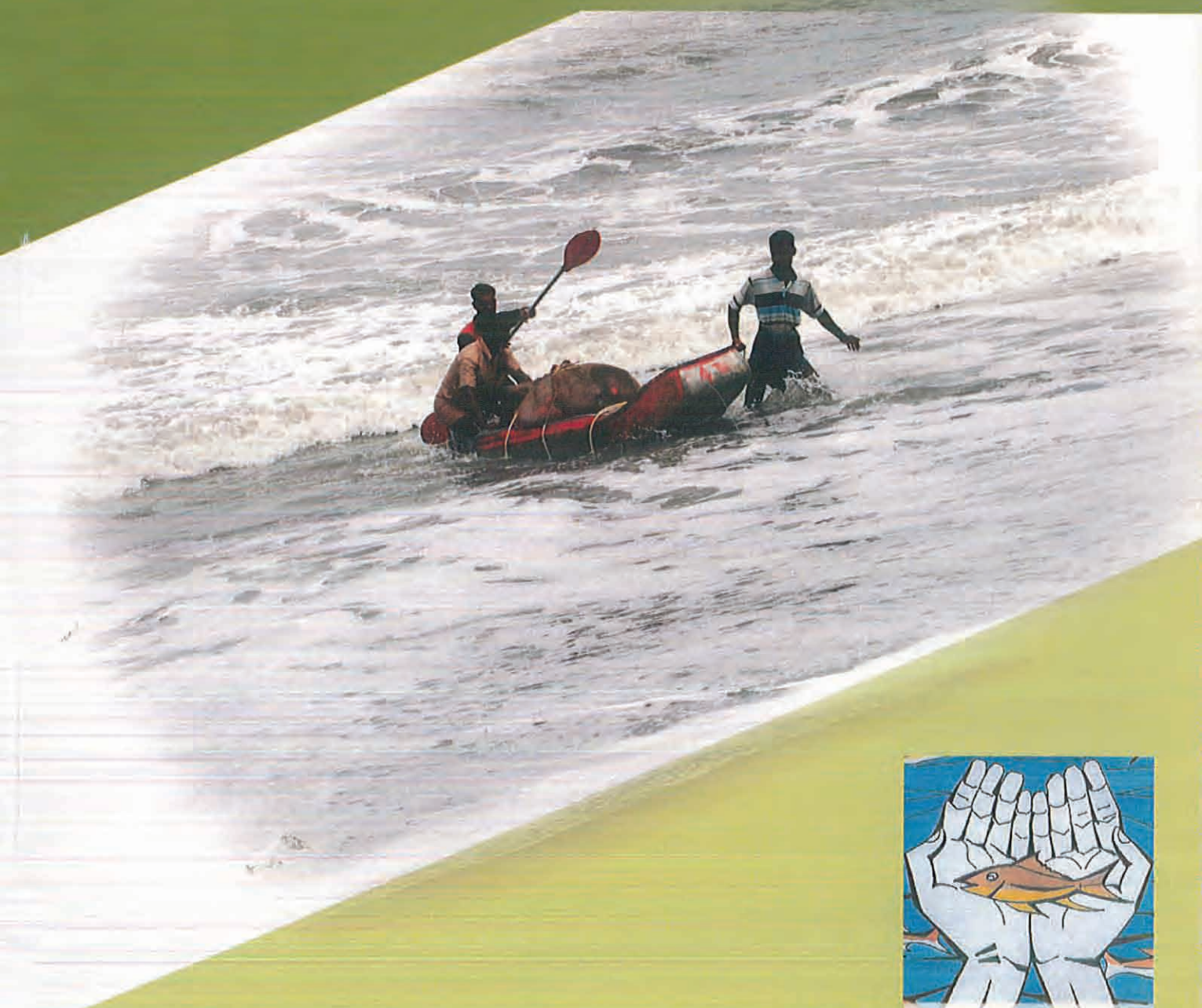


ICAR funded Winter School on
**ICT -oriented Strategic Extension for
Responsible Fisheries Management**

05-25 November 2013



**Socio-Economic Evaluation and
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Central Marine Fisheries Research Institute

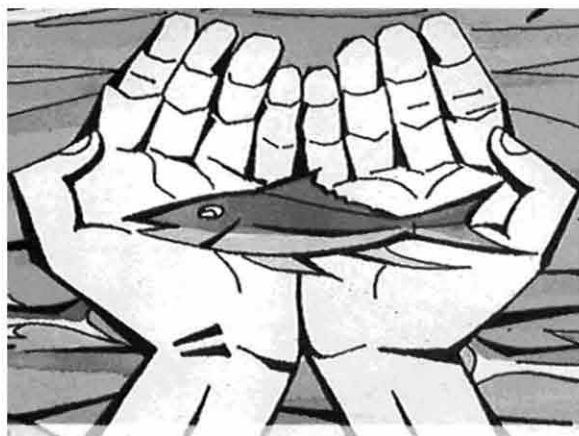
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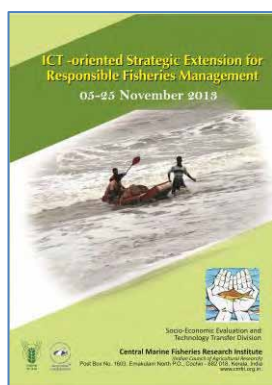


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Front Cover



Back Cover

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The Course Manual is developed as a part of the ICAR funded Short Course on “**ICT -oriented Strategic Extension for Responsible Fisheries Management**” held at Central Marine Fisheries Research Institute, Cochin during 05-25 November, 2013.

Preface

Adoption of Responsible fisheries management--a concept made more famous through the international instrument brought by the UN/FAO namely the Code of Conduct for Responsible Fisheries (CCRF)--is widely agreed as a remedy for the ills of fisheries management like overfishing and noncompliance of regulations, which have been alleged as causes for the dramatic depletion of fish populations in the world's oceans. India, being a signatory to the Code is bound to honour it and the country has witnessed pioneering advances in the promotion of the code, thanks to the biological as well as social science research contributions from CMFRI.

The efforts to engender a scientifically informed fisheries management or governance regime are always challenged by the inherent uncertainty that characterizes the epistemology of fisheries science. The complexity of an otherwise resilient tropical marine ecosystem adds fuel to the fire. And on the Human dimension we have a plethora of challenges despite promising perspectives from Hardin to Ostrom.

It is here that we need to fully appreciate the multitude of challenges we face in a precautionary and participatory framework. We have the instruments /tool box. But the credo of responsible fisheries is yet to become part of the community ethos. What could be the reasons and how we can overcome the barriers? Can we resort to the scintillating opportunities thrown open by the new vistas in Information & Communication Technology (ICT) to address our specific problems? As a concerned stakeholder each one of us has a responsibility to be part of a collective process to not only decipher the answers but also translate them into pragmatic ameliorative strategies.

Through this winter school titled "ICT -oriented Strategic Extension for Responsible Fisheries Management" sponsored by the Indian Council for Agricultural Research (ICAR) and held at Central Marine Fisheries Research Institute (CMFRI) , Kochi during 5-25 November 2013 we tried to provide a platform to share and address these concerns. The participants of the Winter school were from research institutes, universities, and colleges. The faculty of the winter school was from the Central Marine Fisheries Research Institute, Central Institute of Fisheries Technology, Center for Marine Living Resources and Ecology, Kerala Agricultural University, International Collective in Support of Fishworkers, Kerala State Cooperative Federation for Fisheries Development Ltd, World Wide Fund for Nature and other institutes.

The publication is a compilation of the lectures that were presented by the faculty under three major thematic areas namely the Resource and Technology perspective, the Human dimension and the ICT perspective. For the benefit of the participants study tours and practical sessions on the application of ICTs were also conducted. Our endeavour was to impress the participants on the varied facets of the knowledge base we have built and the immense opportunities thrown open by the ICT context to translate the knowledge into a praxis towards a responsible fisheries management regime in the country.

I thank Dr. A. Gopalakrishnan, Director CMFRI for all the support and the ICAR, New Delhi for sponsoring the Winter school. The support given by FAO for providing copies of the CCRF is duly acknowledged. I am grateful to Dr. G. Syda Rao former director, Dr. R . Narayanakumar, Head, SEETTD, Dr. G. Gopakumar, Scientist in Charge Mandapam Regional Center of CMFRI and all members of the CMFRI fraternity in making the School a success.

Kochi

C. Ramachandran

02/11/2013

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Acronyms

AAU	Anand Agricultural University
ADMB	Automatic Differentiation Model Builder
AGMARKNET	Agricultural Marketing Information Network
AHFIN	Assessment of Responsible Fisheries Information Needs
AID	Alternatives for India Development
AIDCP	Agreement on the International Dolphin Conservation Programme
AKIS	Agricultural Knowledge and Information System
AKST	Agriculture Knowledge, Science and Technology
AMS	Aggregate Measure of Support
ARC	Agricultural Research Center
ARFIN	Assessment of Responsible Fisheries Information Need
ARPA	United State Department of Defence Advanced Research Project Agency
ARTFISH	Approaches Rules and Techniques for Fisheries Statistical Monitoring
ATMA PLUS	Agricultural Technology Management Agency plus
B2B	Integrating Agri-Business Partners
BBS	Bulletin Board Service
BFFDA	Brackish water Fish Farmers Development Agency
BIC	Business incubation Centre
BoLD	Barcode of Life Data System
BPO	Business Process Out-Sourcing
BRD	Bycatch Reduction Device
CAGR	Compound Annual Growth Rate
CARI	Central Agriculture Research Institute
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CCRF	Code of Conduct for Responsible Fisheries
CDC	Codex Alimentarius Commission
CDiT	Animators of Center for Imaging Technology
CEDA	Catch Effort Data Analysis
CEU	Cyber Extension Units
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultural Tropical
CIBA	Central Institute for Brackish Water Aquaculture
CIFA	Central Institute of Fresh Water Aquaculture
CIFOR	Center for International Forestry Research
CIFT	Central Institute of Fisheries Technology
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CLAES	Central Laboratory for Agricultural Expert Systems
CMFRI	Central Marine Fisheries Research Institute

CMS	Content Management System
CPC	Consultancy Processing Cell
CPR	Common Property Resources
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSMCRI	Central Salt and Marine Chemical Research Institute
CSNET	Computer Science Network
CSO	Central Statistical Organisation
CSS	Cascading Style Sheet
CTA	Technical Centre for Agricultural and Rural Co-operation
CTI	Computer Telephony Integration
DDA	Doha Development Agenda
DDS	Deccan Development Society
DECU	Development Education and Communication Unit
DHA	Docosaheptaenoic Acid
DIPA	Directorate of Information and Publications of Agriculture
DNS	Domain Name System
DsRNA	Double Stranded Ribonucleic Acid
EAF	Ecosystem Approach to Fisheries
EBFM	Ecosystem Based Fisheries Management
EBM	Ecosystem Based Management
EC	Ecosystem Considerations
ECE	Economic Commission for Europe
EEZ	Exclusive Economic Zone
EISI	Environmental Information Circulation and Monitoring System on the Internet
EKVI	e-Krishi Vipanan Project
EM	Ecosystem Management
ENSO	El Nino Southern Oscillation
EPA	Eicosapentaenoic Acid
ESICM	Expert Systems for improved Crop Management Project
ESTA	Expert System for Text Animation
EU	European Unit
FAD	Fish Aggregating Devices
FAO	Food and Agriculture Organization
FCS	Fisheries Co-Operative Societies
FEW	Fisheries Engineering Wing
FFDA	Fish Farmers Development Agencies
FISH	Fisheries Improved for Sustainable Harvest
FIVIMS	Food Insecurity and Vulnerability Information and Mapping System
FLD	Organizing Frontline Demonstrations
FRP	Fibreglass-Reinforced Plastic
FSI	Fisheries Survey of India
FSSI	Food Safety and Standards Authority
FTP	File Transfer Protocol
FWB	Tamil Nadu Fisheries Welfare Board

G2G	Integration of Government Functions
GATT	General Agreement on Tariffs and Trade
GAUSAT-KRU	Gujarat Satellite Krishi Gosthee
GCR	Growth Constancy Retention
GDEI	Group Dynamics Effectiveness Index
GFMC	Global Fire Monitoring Centre
GI	Geographical Indication
GIS	Geographic Information System
GMF	Genetically Modified Food
GMP	Good Management Practices
GPS	Global Positioning System
HACCP	Hazard Analysis and Critical Control Points
HDL	High Density Lipoprotein
HRD	Human Resource Development
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HUL	Hindustan Unilever Limited
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council for Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICG	Indian Coast Guard
ICRAF	World Agro-Forestry Centre
ICRISAT	International Crop Research Institute for Semi Arid Tropics
ICT	Information and Communication Technology
IEA	Integrated Ecosystem Assessment
IFFCO	Indian Farmers Fertilizer Co-operative Limited
IFPRI	International Food Policy Research Institute
IGNOU	Indira Gandhi National Open University
IIITM-K	Indian Institute of Information Technology and Management Kerala
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organization
INP	Indo Norwegian Project
INPHO	Information Network on Post-harvest Operations
INTERNIC	Internet Network Information Centre
IP	Internet Protocol
IPR's	Intellectual Property Rights
IRRI	International Livestock Research Institute
ISA	International Searching Authorities
ISBA	Indian STEP and Business Incubators Association
ISD	Information System on Desertification
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ISRO	Indian Space Research Organisation

ITQs	Individual Transferring Quotas
ITU	International Telecommunication Union
IWMI	International Water Management Institute
JFE-SSD	The Juvenile Fish Excluder cum Shrimp Sorting Device
KCC	Kisan Call Centres
KHDP	Kerala Horticulture Department Programme
KISSAN	Karshaka Information Systems Services and Networking
KM	Knowledge Management
KMS	Knowledge Management Systems
KRIBHCO	Krishak Bharati Co-operative Limited
KSITM	Kerala State IT Mission
KVSN	Krushikarma Viyapathy Sevaka Niladari
LA	Livelihood Analysis
LDCs	Least Developing Countries
LDL	Low Density Lipoprotein
LIS	Land Information System
LOA	Length Overall
LOSC	United Nations Convention on Law of the Sea
LVFO	Lake Victoria Fisheries Organization
MABs	Multi-Author Blogs
MAC	Marine Aquarium Council
MANAGE	National Institute of Agriculture Extension Management
MAP-IT	Madhya pradesh Agency for Promotion of Information Technology
MAS	Marker assisted selection
MBV	Monodon Baculo Virus
MCS	Monitoring Control and Surveillance
MDGs	Millennium Development Goals
MFI	Micro Finance Institutions
MIEUB	Mobile Internet- Education Unit Boats
MPEDA	Marine Products Export Development Authority
MSC	Marine Stewardship Council
MSME	Micro Small and Medium Enterprises
MSSRF	M. S. Swaminathan Research Foundation
NABARD	National Bank for Agricultural and Rural Development
NAFED	National Agricultural Co-operative Marketing Federation of India LTD
NAIP	National Agricultural Innovation Project
NAL	National Agriculture Library
NAMA	Non-Agricultural Market Access
NARIMS	National Agricultural Research Management Information System
NARIS	National Agriculture Research Information System
NASA	National Aeronautic and Space Administration
NBFGR	National Bureau of Fish Genetic Resources
NCAAH	National Centre for Aquatic Animal Health

NDMC	Namma Dhwani Management Committee
NERN	New Zealand Ecological Restoration Network
NETFISH	Network for Fish Quality Management and Sustainable Fishing
NFDB	National Fisheries Development Board
NFI	National Foundation for India
NGOs	Non-Governmental Organization
NIC	National Informatics Centre
NICRA	National Initiative on Climate Resilient Agriculture
NISO	National Information Standards Organization
NPAs	Non Performing Assets
NRM	Natural Resource Management
NSF	National Science Foundation
NTBs	Non-Tariff barriers
ODI	Overseas Development Institute
ODINCINDIO	Ocean Data and information Network for the Central Indian Ocean region
OFT	Conducting on-farm testing
OSS	Observatory for the Sahel and the Sahara
PAFID	The Philippine Association For Intercultural Development
PAFID	Philippine Association For Intercultural Development
PCT	Patent Cooperation Treaty Application
PE	Poly Ethylene
PLA	Participatory Learning Action
PP	Payback Period
PPGIS	Public Participation GIS
PPMs	Production and Processing Methods
PRA	Participatory Rural Appraisal
QR	Quantitative Restrictions
R&D	Research and Development Organisations
RAPD	Random Amplified Polymorphic DNA
RFEM	Responsible Fisheries Extension Module
RNAi	RNA Interference
RPF	Research Project File
SAMETIs	State Level Agricultural Extension and Management Training Institutions
SAT	Semi Arid Tropics
SATCOM	Satellite Communications
SBI	State Bank of India
SE	Solution Exchange
SEETTD	Socio-Economic Evaluation and Technology Transfer Division
SEM	Structural Equation Model
SIDALC	Agriculture Information and Documentation Service for America
SIFFS	South Indian Federation of Fishermen Societies
SPS	Sanitary and Phyto-sanitary measures
SRI	Stanford Research Institute
SSB	Spawning Stock Biomass

SSKs	Sardar Smriti Kendras
SSS	Shidhulai Swanirvar Sangstha
T & V	Training and Visit System
TAC	Total Allowable Catch
TAE	Total Allowable Effort
TAFCOFED	Tamil Nadu State Apex Fisheries Cooperative Federation Limited
TANUVAS	Tamil Nadu University of Veterinary and Animal Sciences
TBT	Technical Barriers to Trade
TCL	Tata Chemicals Limited
TCP	Transmission Control Protocol
TEDs	Turtle Excluder Devices
TFH	Thoothukudi Fishing Harbour
TFP	Total Factor Productivity
TMAO	Trimethylamine Oxide
TNFDC	Tamil Nadu Fisheries Development Corporation
TOT	Transfer of Technology
TQM	Total Quality Management
TRF	Thailand Research Fund
TRIMS	Trade Related Investment Measures
TRIPS	Trade Related Intellectual Property Right
UBRA	The Uma Bawang Resident's Association
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNO	United Nations Organizations
UPS	Uninterruptible Power Supply Unit
URI	Uniform Resource Identifier
URLs	Uniform Resource Locators
USAID	US Agency for International Development
VASAT	Virtual Academy for the Semi Arid Tropics
vBNS	Very High Speed Backbone Network Service
VC	Video Conferencing
VERCON	Virtual Extension and Research Communication Network
VoIP	Voice over Internet Protocol
WFC	World Fish Center
WSS	White Spot Syndrome
WSSV	White Spot Syndrome Viral
WTO	World Trade Organization
WWF	World Wide Fund for Nature
WWW	World Wide Web
YCMOU	Yeshwantrao Chavan Maharashtra Open University
ZTM-BPD	Zonal Technology Management-Business Planning and Development Unit



Responsible Fisheries Management: Resource & Technology Perspective

Responsible Fisheries Management and ICT -A pragmatic approach towards Challenges and Pathways ahead

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Information and Communication Technology (ICT) has a significant role to play in Responsible fisheries management in India. In this lecture the concept of Responsible Fisheries management based on the FAO Code of Conduct for Responsible Fisheries is briefly touched upon before throwing some light on the ICT opportunities and pathways that emerge in the context of attempts to promote an ethos of responsible fisheries management among the different stakeholder constituencies.

Responsible fisheries management, for all practical purposes of the term, is conceived of the following dimensions

- a) Promotion of the FAO Code of Conduct for Responsible Fisheries as the guideline that define our approaches to fisheries management
- b) The appreciation of the fundamental role of the State in ensuring management of fisheries resources in a sustainable manner
- c) Empowerment of different stakeholders to become responsible stewards/trustees in the management of common pool resources
- d) Elucidation of ways to bring the market also as an active management stakeholder

The FAO Code of Conduct for Responsible Fisheries (FAO CCRF) is considered as a landmark document symbolizing the international consensus achieved on the necessity for providing guidelines to ensure sustainable utilization of fisheries resources of the world.

Why the Code?

That the sustainability of marine capture fisheries at the current level of harvesting is at stake is no longer a moot point. It is being realized that fisheries anywhere in the world is more a socioeconomic process with biological constraints than anything else. The open

access nature of the resource coupled with unregulated penetration of advanced, but not necessarily ecofriendly, harvesting technologies (a phenomenon called *technological creep*) has enacted a virtual “tragedy of the commons” in our seas. Making the issue still more complex, especially in the context of the Millennium Development Goals, is the rampant poverty existing among our fisher folk though the capture fisheries makes significant foreign exchange contribution in our country.

Foundations of the Code

If there are no technological magical bullets for the current impasse what is the way out? This is precisely the question the FAO code is trying to answer. “*The right to fish carries along with it an obligation to do it responsibly*” is the cardinal principle of the code. This principle is built on the foundation of what is known as a Precautionary Approach. Precautionary approach, which originally was proposed as Principle 15 of Agenda 21 the Rio Earth Summit meeting in 1992, enunciates that “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”. While in simple terms the precautionary approach means “better safe than sorry”, it clearly recognizes that changes in fisheries systems are only slowly reversible, difficult to control, not well understood, and subject to changing environment and human values. It involves the application of prudent foresight. It is about applying judicious and responsible fisheries management practices, based on sound scientific research and analysis proactively rather than reactively to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future as well as current generations.

Taking account of the uncertainties in fisheries systems and the need to take action on incomplete knowledge, it requires, *inter alia*: **a.** consideration of the needs of future generations and avoidance of changes that are not potentially reversible; **b.** prior identification of undesirable outcomes and of measures that will avoid them or correct them promptly; **c.** that any necessary corrective measures are initiated without delay, and that they should achieve their purpose promptly, on a timescale not exceeding two or three decades; **d.** that where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource; **e.** that harvesting and processing capacity should be commensurate with estimated sustainable levels of resource, and that increases in capacity should be further contained when resource productivity is highly uncertain; **f.** all fishing activities must have prior management authorization and be subject to periodic review; **g.** an established legal and institutional framework for fishery management, within which management plans that implement the above points are instituted for each fishery, and **h.** appropriate placement of the burden of proof by adhering to the requirements above.

The reversal of burden of proof means that those hoping to exploit our marine resources must demonstrate that no ecologically significant long-term damage will result due to their action. Or in other words human actions are assumed to be harmful unless proven otherwise.

Contents of the Code

The code provides a necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment. It is achieved through 12 articles covering areas like nature and scope of the code (article 1) objectives of the code (article 2), relationship with other international instruments (article 3), implementation, monitoring and updating (article 4), special requirements of developing countries (article 5), general principles (article 6), fisheries management (article 7), fishing operations (article 8), aquaculture development (article 9), integration of fisheries into coastal area management (article 10), post-harvest practices and trade (article 11), and fisheries research (article 12).

Characteristics of the Code

The most salient feature of the code is that it is *voluntary* in nature. Unlike other international agreements like UN Agreement to Promote Compliance with International Conservation and Management Measures by Fishing vessels on the High Seas or the Straddling Stock Agreement, 1995, it is not legally binding and violation of the code cannot be challenged in a court of law.

It would be tempting to castigate it as an Achilles' heel and thus futility of the code. But it should be remembered, "open access imbroglios" can not be resolved through attempts that fail to recognize altruistic spirit of the human actors. In a situation where "you and your enemy belongs to the same system, solutions must be found in managing relationships". It doesn't mean that the code is impractical or ineffective. A fundamental objective of CCRF is "to serve as an instrument of reference to help states to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures." The policies of the state for managing the fisheries resources should be based on the provisions of the code.

If world fisheries are to be sustainable in the long term, structural adjustment within the fisheries sector is required. Although policy decisions in this regard must be made by national governments, effective implementation of the code requires the participation and cooperation of a wide range of stakeholders, including fishers, processors, NGOs and consumers. Implementation of the code is primarily the responsibility of states. The code will require regional and sectoral implementation in order to address the particular needs of fisheries in different regions or sub-sectors.

The Code and CMFRI Initiatives

It is in this context that the actions and initiatives being taken by CMFRI, mainly through an NATP funded research project titled "Designing and validation of communication strategies for responsible fisheries –a co-learning approach" become relevant. A Responsible Fisheries Extension Module (RFEM), which consists of 13 tools including a Malayalam translation of the code, animation films in all maritime languages etc. developed have been widely used to create awareness among the fisherfolk. A statewide campaign on Responsible Fisheries was launched and the RFEM was released for further scaling up by the respective State Fisheries Departments. These mass

communication tools have the potential to reach almost 85 % of the fisher folk and other stakeholders in the country. It is reasonable to conclude that CMFRI has made a pioneering initiative in the cause of popularization of the concept of Responsible Fisheries in India.

Though the voluntary nature of the code has been necessary in getting the all-nation agreement when it was drafted in the early 1990s, attitudes to the oceans have changed (Pitcher *et al.*, 2009). There is now widespread scientific consensus on the ecological impacts of continued over-fishing and the threats to seafood security and broad agreement on policy issues such as curtailing illegal catches and minimizing the impacts of fishing on marine ecosystems. The basic requirement for adoption of Ecosystem Approach is a dynamic knowledge base on stock assessment. The stock assessment knowledge base generated and continuously maintained by CMFRI is a unique achievement among the developing tropical context countries. But the utility of this Knowledge base in translating into management praxis is less appreciated. There still exists a communication divide between the research system and the fisheries management system in the country.

Though the communication tools and strategies already developed by the institute have been useful in creating awareness on the need for sustainable /responsible fisheries there is a need to develop and scale up specific communication interventions to sensitize the stakeholders in making a transition towards ecosystem based approaches that ensure responsible management of our waters. Fisheries management is fisher management and participatory approaches informed/initiated by a proactive research system taking place in a democratic and decentralized civil society space is globally accepted as the key to Ecosystem Based Fisheries Management. The future is decided by the capacity we build today amongst the different stakeholders responsible for sustainably utilizing the marine fisheries resources of our country. It is with this objective that we are continuing the efforts in this line through a new institute funded research project “Capacity Development for Ecosystem Based Responsible Fisheries Management in India - A Co-Learning action research” (FISHCMFRISIL201202200022) during 2012-17.

Sustainable Management of resources is no different from fisheries development. They are no longer considered as dichotomous. There will be no fisheries development if there is not enough fish in the sea. There won't be enough fish in the sea if human beings, both as harvesters and consumers, do not act in a precautionary manner which is nothing but to nurture a feeling of “better safe today than sorry tomorrow”. It means to understand clearly the limits to which nature can be tapped. The requirements of both the present generation and future generation are to be given equal importance. It is also about respecting the co-evolutionary culture of a fisheries-resource dependent community. Thus Responsible Fisheries management takes place at the dynamic interface between the behavior of man and that of fish. So it is a convergence of biology, socio-politics, ecology, economics, engineering, law and communication. The aim of fisheries management is to ensure optimum utilization of a common pool resource without jeopardising the inherent regenerative ability of the resource leading to livelihood security of the dependent community.

ICT and Responsible Fisheries Management

Much has been said about rights-based fisheries, fisheries co-management and ecosystem-based fisheries management with fisheries managers, policy-makers, scientist and researchers racking their brains about the meaning of each of these fisheries management approaches. In trying to find definitions and formulating “how-to” guidelines and handbooks on such fisheries management approaches, their essential ingredient often is overlooked, namely dialogue. Whether talking of co-management and partnerships between fisheries stakeholders or of the adaptive nature of ecosystem-based fisheries management the fundamental nature of any fisheries management effort is the communication process among its various protagonists. Neither a partnership between fishing communities, fisheries managers, researchers and other stakeholders, nor the merging of the development goals of human well-being with that of ecological well-being through an ecosystem-based fisheries management approach would be possible without free-flowing information among the various partners in the management process.

These communication processes can take many different forms and can be designed according to a diversity of purposes: (1) to meet specific fisheries management objectives, needs and aspirations for the fisheries sector; and 2) to generate new information about local fisheries systems through participatory (eg.catch-reporting) mechanisms. The experiences from these activities should encourage fisheries managers, scientists, and fishing communities to actively seek such dialogue and information exchange as a basis for improving fisheries management on a ecosystem approach.

The efforts to engender a scientifically informed fisheries management or governance regime are always challenged by the inherent uncertainty that characterizes the epistemology of fisheries science. The complexity of an otherwise resilient tropical marine ecosystem adds fuel to the fire. And on the Human dimension we have a plethora of challenges despite promising perspectives from Hardin to Ostrom.

It is here that we need to fully appreciate the multitude of challenges we face in a precautionary and participatory framework. We have the instruments /tool box . But the credo of responsible fisheries is yet to become part of the community ethos. What could be the reasons and how we can overcome the barriers? Can we resort to the scintillating opportunities thrown open by the new vistas in Information& Communication technology to address our specific problems? As a concerned stakeholder each one of us has a responsibility to be part of a collective process to not only decipher the answers but also translate them into pragmatic ameliorative strategies.

What this winter school has tried to offer is such a platform-a platform to share and learn in a liberating atmosphere of participatory co-learning . Remember , we no longer hail a banking system of pedagogy in our school. It is the way the fish in water is... dynamic and dialectic. However the areas we cover during the course under three major modules namely a) RFM-the resource and technological perspective, b) RFM- the Human dimension and c) RFM- the ICT perspective include: Concept ,philosophy and logic of Responsible Fisheries, National and international instruments, Epistemological and historical perspectives, Resource Perspectives on Responsible Fisheries Management (Pelagic, demersal, molluscan and crustacean), Introduction to stock assessment and monitoring,

Fisheries management /governance tool box, Sociological ,Political ecology and Economic perspectives of NRM, Property rights regimes, Alternative Livelihood Options especially Mariculture, Human dimension and Gender issues, ICT theory and praxis, Responsible Fisheries Extension, Co-management, Fisheries policy, Emerging issues like Climate change and Ecosystem approaches.

ICT pathways - a prelude

The term ICT is taken as the convergence of different communication technologies like mobile phones, remote sensing, internet, radio, and TV . ICTs can be defined as “technologies that facilitate communication and the processing and transmission of information by electronic means”

It is interesting to note that the hybridity of ICT should fit well with the kind of hybridity demanded for a system of responsible fisheries management. Let us see how this is made possible .

The following table analyses how the various challenges that emerge in this context offer opportunities as ICT pathways.

Table 1: Challenges, Opportunities, ICT pathways and outcomes in Fisheries sector

Challenge	Opportunity	ICT pathway	outcome
A) Epistemological divide	Participatory Stock Assessment Combining indigenous knowledge Chlorophyll based validation of Potential Yield	Inputting of Real time data through ICT enabled devices (Video based assessment)	Better data- better science; better decisions cost saving Better partnership and trust by fishfolk in Science based management
B)Communication divide a) Science and management	Management advisories	Delivery through ICT platforms (Information kiosks)	Informed managers
b) Science and Policy	Scientific decision making	Knowledge platforms for sharing and negotiation (Video conferencing)	Informed policy making; Co management

c) Management and stakeholders -Fisherfolk	<p>PFZ advisories Awareness on regulations rights and responsibilities</p> <p>Energy management Vessel monitoring</p> <p>On line registration of vessels</p> <p>Weather forecasts</p> <p>Climate change adaptation</p> <p>Market intelligence</p> <p>Experience sharing</p>	<p>Satellite based and GIS based data delivery</p> <p>Use of mobile phones</p> <p>Use of internet kiosks M Krishi E Choupal models</p> <p>Fishwatch (CMFRI)</p> <p>Internet based platform can be developed (similar to Australian one)</p>	<p>Reduction of carbon footprint</p> <p>Better compliance of regulations</p> <p>Better implementation of CCRF</p> <p>Better Monitoring of management interventions</p> <p>Less exploitation by middlemen</p> <p>Better sea safety</p> <p>Documentation of tacit knowledge</p>
-Fisherwomen	Post harvest niche market opportunities	Internet based gadgets, mobile phones	Empowerment
-Young fishers	<p>Education on stewardship</p> <p>Empowerment on alternative livelihood options</p>	<p>Tailor made Educational programmes on interactive mode; CD roms</p> <p>Career guidance</p>	
-Traders	<p>Market intelligence</p> <p>ICT enabled auction places can be developed</p> <p>E -commerce</p>	<p>Mobile phones Dutch clock system combined with e -commerce</p> <p>Eg.Lonxanet Spain</p>	<p>Transparent transactions, less middlemen exploitation</p> <p>Fishing better not fishing more</p>
Processors	Quality intelligence	internet	
-Consumers	<p>-Responsible consumption</p> <p>-Sustainable sourcing</p> <p>-Price information</p> <p>-Nutrition</p>	Internet marketing	

	information		
C) Coastal Zone Management	Spatial planning of coastal infrastructure including fisherfolk's dwellings Pollution watch	GIS supplemented by PRA	Better management and monitoring
D) Disaster management	sea safety, sea rescue operations Reducing Cross border fishing casualties	GIS+ mobile phones	Better coordination
E) Resource augmentation	Deployment of FADs, MPAs, open sea cage culture	GIS mapping	Better monitoring
H) Traceability, quality	Labelling the fishery products	internet	Quality assurance, value chain monitoring

Concluding remarks

It is obvious that the opportunities are immense in making use of ICT platforms not only as delivery points but also as “bridging devices” that could reduce the disconnect existing between the different stakeholder constituencies. The table captures the potential areas in general. Some are generic opportunities. The application of specific ICT pathways is a function of the problem context as well as resource endowments of the community including the social capital. Extension organizations being boundary organizations should take the initiative to harness the emerging ICT opportunities.

Our marine resources need careful protection and stewardship. In this regard, it is worth noting that CMFRI, through its multifaceted research activities and outreach programmes for the last five decades, has been committed to promote the idea of responsible fisheries in the country. The winter school has been an attempt to revisit the epistemological foundations and thus assimilate cognitive energy to reorient our pragmatic efforts through ICT enabled platforms of continuous dialogue as well as capacity building. Nevertheless when the school comes to an end I feel, as the famous novel by Nikoz Kazanzsakis ends “*He made a crya triumphant cry “It is accomplished!” and it was as though he had said: “Everything has begun!”*”

Further reading

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Status of Marine Fisheries Resources in India – An Overview

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The fisheries sector plays an important role in Indian economy and its contribution to the GDP is about one percent. Export earnings from marine sector have increased from Rs. 3.92 crores in 1961-62 to Rs. 12,901.47 crores in 2010-11 with 11.8% growth during 2009-10. There are 0.99 million active fishermen employed directly and 0.61 million employed indirectly with the marine fisheries sector. The total fisher folk population in the country is 4.00 million and there are about 1,94,490 fishing crafts operated in the country for harvesting marine fishery resources (CMFRI, 2010). Out of this about 72,500 are mechanized crafts, 71,300 are motorized and the rest are non-mechanized. In mechanized sector there are about 35,200 trawlers. Fishing by all these crafts are concentrated in the depth zone up to 100 m. The traditional crafts and motorized crafts are concentrated more in the east coast (72% and 58%) where as the mechanized vessels are more along the west coast (58%).

India is a tropical country with multi-species fishery in the marine sector. Various types of fishing crafts and gears are used for fishing from the seas. The development of fisheries sector in India can be classified into three phases. Prior to 1965-66 is the first phase when landings were mainly by non-mechanized indigenous crafts and gears and the landings remained below one million tonnes during this phase. The second phase is the period upto 1985-86 and the important features of this phase were increased mechanization, improved gear materials, introduction of motorization of country crafts, expansion of export trade etc. The last phase is the period after 1986. This phase featured intensification of mechanization, motorization of country crafts, multi-day voyage fishing etc. The average contribution from west coast is 67% and that from the east coast is 33%. The overall percentage contribution from the four regions are NE 11.4%, SE 22.0%, SW 35.2% and NW 31.4%. Pelagic fin fishes formed 55%, Demersal 26%, Crustaceans 15% and Molluscs 4%. As per the Silas committee (2000), the potential yield of marine fishery resources in the Indian EEZ is 3.93 million tonnes.

There are about 2000 marine species that are caught from the Indian seas. Over years changes have occurred in the type of fishing, crafts and gears used, time spend in the sea for harvesting the resources, storage and infrastructural facilities, commercial

importance, export demand etc. Fish is one of the costliest items of food in the present days. The gross revenue from the marine fish landings during 2009-10 at the point of first sales (landing centre) was estimated at Rs.19,753 crores (CMFRI, 2011). There are more resources that are exported now and from India marine products are exported to nearly 100 countries. Since marine fishery resources are renewable and not in-exhaustible management and conservation of these resources are very much essential for sustained production from the seas. Thus, monitoring the harvest of different marine fishery resources is of great concern. With this view, Central Marine Fisheries Research Institute (CMFRI) has developed a sampling design for collecting the required information and to estimate marine fish landings along with effort expended. The sampling design adopted is based on stratified multi-stage random sampling technique, with stratification over space and time. The harvest potential of each of the commercially important marine fishery resources have to be periodically revalidated along with the optimum size of different types of fleets operating in the fishery.

Table 1: Profile of Indian Marine Fisheries

Component		Profile
Physical Component		
	Length of coastline	8129 km
	Exclusive economic zone	2.02 million km ²
	Continental shelf	0.50 million km ²
	Inshore area (< 50 m depth)	0.18 million km ²
	Fishing villages	3288
Human Component		
	Marine fishers population	4.0 million
	Active fishers population	0.99 million
	Fishermen families	0.86 million
Infrastructure Component		
	Landing centers	1511
	Major fishing harbours	6
	Minor fishing harbours	27
	Mechanised vessels	72559
	Motorised vessels	71313
	Non-motorised vessels	50618

Estimation of Marine fish landings in India

India is one among few countries where a system based on sampling theory is used to collect marine fish catch statistics. The sampling design adopted by the CMFRI to estimate marine fish landings is based on stratified multistage random sampling technique, stratification being done over space and time. CMFRI initiated the process of collection of data on marine fish catch, effort, biological parameters

etc. based on scientific principles way back in 1947. In 1959 CMFRI initiated collection of marine fish landings data along the west coast of India through a stratified multistage sampling design. The sampling design became operational in 1961 for both east and west coasts.

Table 2: Indian Marine Fisheries Statistics

Gross value at landing centre	Rs. 19,753 crores
At retail points	Rs. 28,511 crores
Export earnings	US\$ 3.5 billion
Percentage in total exports	3%
Domestic markets	81% fresh; 5% frozen; 6% dry; 5% fish meal
Per capita fish consumption	2.58 kg (range 0.3 – 39)
Share in GDP	1.1%
Share in agricultural GDP	5.4%

Marine Fish Production

Table 3: Top-ten Resources by Value (Landing centre prices)

Rank	Resource/ Stock	Rs. Billion	US\$ Million
1	Penaeid shrimps	43.4	964.4
2	Sardines	10.7	237.8
3	Cephalopods	9.0	200.0
4	Seerfishes	6.0	133.4
5	Pomfrets	5.8	128.9
6	Croakers	4.6	102.2
7	Carangids	4.6	102.2
8	Mackerel	3.9	86.7
9	Perches	3.9	86.7
10	Bombay duck	2.5	55.6
	Others	15.6	346.7
	TOTAL	110	2446.6

Table 4: Top-ten Resources by Quantity (lakh tonnes)

Name of fish	Average landings (2008-2012)	Percentage
Oil sardine	5.35	15.28
Penaeid prawns	2.48	7.07
Indian mackerel	2.12	6.04
CROAKERS	2.01	5.73
RIBBON FISHES	1.86	5.32
Non-penaeid prawns	1.67	4.78
Threadfin breams	1.55	4.42
BOMBAYDUCK	1.11	3.17
Other sardines	1.16	3.31
Catfishes	0.93	2.66
Total	20.24	

Table 5: State wise contribution in marine fish landings (lakh tonnes)

State	2012		Average (2008-2012)	
	Landings	%	Landings	%
Kerala	8.39	21.31	6.76	19.29
Gujarat & Daman-Diu	8.28	21.03	6.68	19.06
Tamil Nadu	6.45	16.38	5.49	15.67
Karnataka	4.75	12.07	3.73	10.64
Maharashtra	3.15	8.00	3.04	8.68
Andhra Pradesh	3.04	7.72	2.60	7.42
Orissa	2.48	6.30	2.67	7.62
West Bengal	1.55	3.94	3.07	8.76
Goa	0.72	1.83	0.80	2.28
Pondicherry	0.56	1.42	0.20	0.57
Total	39.37	100.00	35.04	100.00

Table 6: Gear wise contribution in marine fish landings (2008-2012 average)

Gear Name	Landings (lakh tonnes)	%	CPUE (Kg/unit)	CPUE (Kg/hour)
Mechanized Trawlnet	17.76	50.68	1472	48
Mechanized Dolnet	2.35	6.71	590	58
Mechanized Gillnet	1.92	5.48	547	17
Mechanized Purseine	2.06	5.88	2550	411
Mechanized Ringseine	2.20	6.28	3002	1264
Mechanized Bagnet	0.36	1.03	395	65
Mechanized Hooks & Lines	0.05	0.14	420	11
Other mechanized gears	0.26	0.74	2915	26
Outboard Gillnet	3.08	8.79	76	13
Outboard Ringseine	2.61	7.45	1021	462
Outboard Hooks & Lines	0.59	1.68	80	14
Outboard Bagnet	0.37	1.06	208	38
Outboard Boatseine	0.15	0.43	195	68
Outboard Purseine	0.14	0.40	743	286
Other outboard gears	0.22	0.63	88	17
Non-mechanized gears	0.92	2.63	48	15
Total	35.04	100.00		

What do we exploit from the sea?

Marine fisheries in India is a multi-species fishery. Around 1400 finfish species are harvested from the sea of which 263 are commercially important. Apart from this 36 species of penaeid shrimps and 34 species of cephalopods are also harvested in which 15 species of penaeids and 8 species of cephalopos are commercially important.

How the exploitation is carried out?

The marine fishery resources from the Indian seas are harvested using more than 35 different types of craft gear combinations. The major crafts used are of three different categories namely mechanized, motorized and non-motorized. The mechanized sector include trawlers, gill-netters and inboard vessels. Most of the crafts in the mechanized sector use machines for both propulsion and operation of the gear. The motorized sector exclusively consists of crafts fitted with outboard engines. The non-motorized sector consists of traditional vessels made up of wood, fibre glass, thermo coal etc. and do not use any machine power either for propulsion or for operation of the gear. Major gears used in the marine fisheries sector are trawl nets, gill nets, bag nets, hooks & lines and seines.

Trawl fisheries

It is the major gear accounting for 51% of landings. Number of trawlers and engine horse power increased over time. Deep sea fishing upto 400 m depth from 1999. The medium trawlers undertake multi-day voyages. They carry different trawl nets having different cod-end mesh sizes (15 to 35 mm) to target sea high value resources. Penaeid shrimps form the main catch. High opening trawls catch squid, cuttle fish and fishes. Finfishes exploited by trawls belong to 21 major groups.

Seine Fisheries

Ring Seine is the most popular seining method for the pelagics along Kerala coast. Purse seiners operated in Kerala, Karnataka, Goa and Maharashtra. Main species - small pelagics such as oil sardine, lesser sardines, anchovies and mackerel.

Gillnet Fisheries

The gillnet catches increased by more than 4 times in recent years (5.8 lakh t in 2008). Share of mechanized gillnetters increased compared to outboard gillnetters. Small meshed gillnets catch clupeids and croakers. Large meshed gill nets catch sharks, seerfish, mackerels, catfishes, pomfrets, tunas and carangids

Bag net Fisheries

Major gear used by artisanal fishers along NW and NE coasts. Gujarat and Maharashtra, a fixed variety of bag nets (Dolnets). Dolnets operate upto 40 m. 80% of the bag net fisheries come from the mechanized dolnetters. Resources caught are non-penaeid shrimps (*Acetes indicus*), Bombay duck (*Harpadon nehereus*), golden anchovy (*Coilia dussumeri*) as well as penaeid shrimps and ribbonfishes.

Hooks and Line Fisheries

Contributes to 2% of the all India marine fish catch. Targets large pelagic fishes such as sharks, tunas and barracudas. Development schemes promote H&L fisheries particularly the modern version - long line fishing for tunas.

Artisanal Fisheries

It dwindled with the advent of mechanization from 88 % in 1960 to 2 % recently. Catamaran and plank built boats have been motorised.

Bivalve fishery

Clams and mussels mainly in inland waters and bays; hand picking and by dredge. Kerala leads in the production of clams - 66,000 tons (t) in 2008-09

Marine Fisheries Management in India

In India, fishery in general is open access fishery which is governed by different acts introduced by the government over the years

- Indian Fisheries Act, 1897
- The Wild Life (Protection) Act, 1972
- MFR (regulation) Bill, 1978 formulated after the EEZ declaration
- MFRA of maritime states enacted from 1980 in all maritime states
- Maritime Zones of India Act, 1981
- Environment (Protection) Act, 1986

Regulatory Measures

- Closed season
- Closed fishing areas
- Marine Protected Areas (MPAs)
- Protected Species
- Ban on certain destructive fishing gears and methods
- Minimum mesh size regulation
- Minimum legal size at capture
- Use of Turtle Excluder Device (TED) in trawls in Orissa

Table 7: Closed Season for Mechanized Sector

State	Months	Days
Gujarat	June - August	45
Maharashtra	June - August	45
Goa	June - August	60
Karnataka	June - August	45
Kerala	June - August	45
Tamil Nadu	April - May	45
Andhra Pradesh	April - May	45
Orissa	April - May	45
West Bengal	April - May	45

Table 8: Spatial closures

State	Reserved for traditional vessels	Available to mechanized vessels
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Goa	Up to 5 km	Beyond 5 km
Kerala	Up to 10 km	<25 GRT: 10-22 km; >25 GRT: beyond 23 km
Karnataka	Up to 6 km	<15m LOA: 6-20 km; >15m LOA: beyond 20 km
Maharashtra	Up to 5-10 fathom	Beyond 10 fathom depth
Tamil Nadu	Up to 3.4 nautical miles	Beyond to 3.4 nautical miles
Andhra Pradesh	Up to 10 km	<20m LOA: 10-23 km; >20m LOA: beyond 23 km
Orissa	Up to 5 km	<15m LOA: 5-10km; >15m LOA: beyond 20 km

MARINE PROTECTED AREAS (MPAs)

- Currently, there are 31 MPAs (majority in A&N)
- The current area under MPAs is 6.16 per cent of the area in the coastal biogeographic, which is proposed to be expanded to 7.12 per cent
- Oil wells in Bombay High and Godavari Basin also function as MPAs

Table 9: Protected Species (under Indian Wildlife Protection Act, 1972)

Species/ Group	Number
Molluscs	24 species
Elasmobranchs	10 species
Grouper fish	1 species
Sea horses	All species
Sea Cucumber	All species
Sponges and seafans	All species
Corals	All species
Turtles	All 5 species
Whales, dolphins, sea cow	All species

Table 10: Minimum Legal Sizes

Species	Weight (g)/ Length (mm)
<i>Panulirus polyphagus</i>	300 g
<i>P. homarus</i>	200 g
<i>P. ornatus</i>	500 g
<i>Thenus orientalis</i>	150 g
<i>Pampus argenteus</i>	200 g
<i>Loligo duvauceli</i>	80 mm
<i>Sepia pharaonis</i>	115 mm
<i>Octopus membranaceous</i>	45 mm

Ban on Destructive Fishing Methods

- Dynamite fishing
- Cyanide poisoning
- Pair trawling in GoM and Palk Bay
- Thalluvalai (minitrawl) in GoM and Palk Bay

Management and conservation of the resources

- Ecosystem-based fisheries management (EBFM) better than single species mgmt, ecosystem evaluation and modeling, can predict changes
- Bycatch reduction- BRDs and sem pelagic trawling
- Capacity reduction- limit entry, buyback
- Understanding climate variability and fisheries-improved information on climate and effects made available
- Implementation of CCRF -overexploitation of stocks, damage to ecosystems, trade issues: ecolabeling
- Natural hazards – disaster management plans
- Mariculture- potential mariculture site identification
- Development of Infrastructure- post harvest loss -15%, public investment, VMS, better domestic marketing
- Diversification of vessels and deep sea fishing- 1.3 lakh t of deep sea resources- tuna longliners and squid jiggers
- Diversification of products -value added products
- Utilisation of fish waste to useful products
- Marine Protected Areas (MPAs)-area to expand to 7.12%

Habitat degradation

- water contamination
- enforcement of standards for water discharge
- maintaining the quality of river runoff

- reducing greenhouse gas emissions

Major items of export

Frozen Shrimp continued to be the major export value item accounting for 49.63% of the total US \$ earnings. Shrimp exports during the period increased by 24.86%, 42.97% and 37.99% in quantity, rupee value and US\$ value respectively. Fish, has retained its position as the principal export item in quantity terms and the second largest export item in value terms, accounted for a share of about 40.27% in quantity and 19.48% in US\$ earnings. Frozen Cuttlefish recorded a growth of 21.92% in rupee value and 15.58% in USD terms. Unit value also increased by 25.06%, however, there is a decline in quantity (7.59%). Export of Frozen Squid showed an increase of 21.53% in rupee value and 17.46% in US\$ realization. Unit value also increased by 32.95%. However, there is a decrease of 11.65% in terms of quantity. Live items also showed a growth of 8.76% in terms of rupee value and 3.18 % in terms of US\$ realization compared to the previous year. Dried items showed a drastic decline in quantity, value and US\$ terms by 32.05%, 41.08%, and 44.56% respectively.

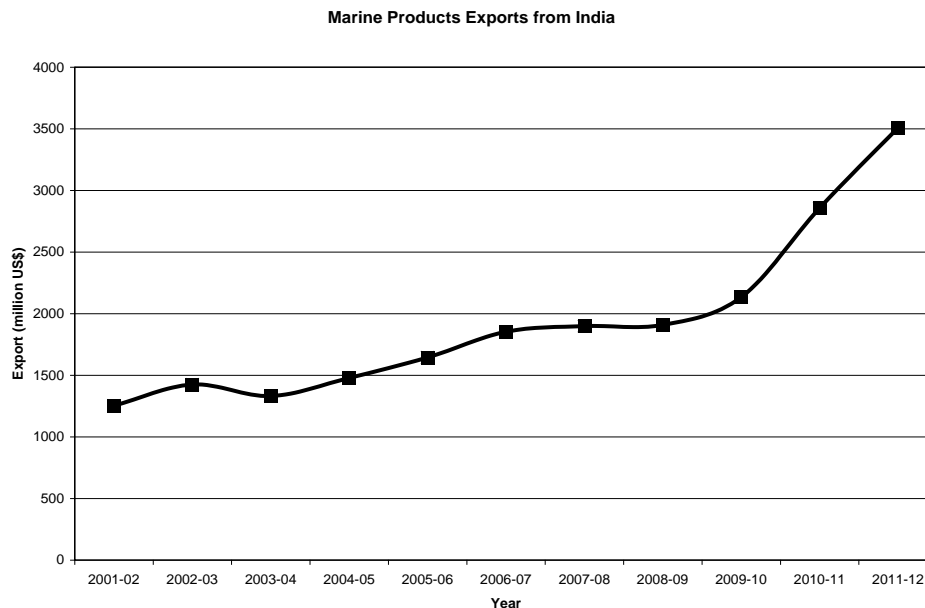


Fig. 1: Marine Products Exports from India

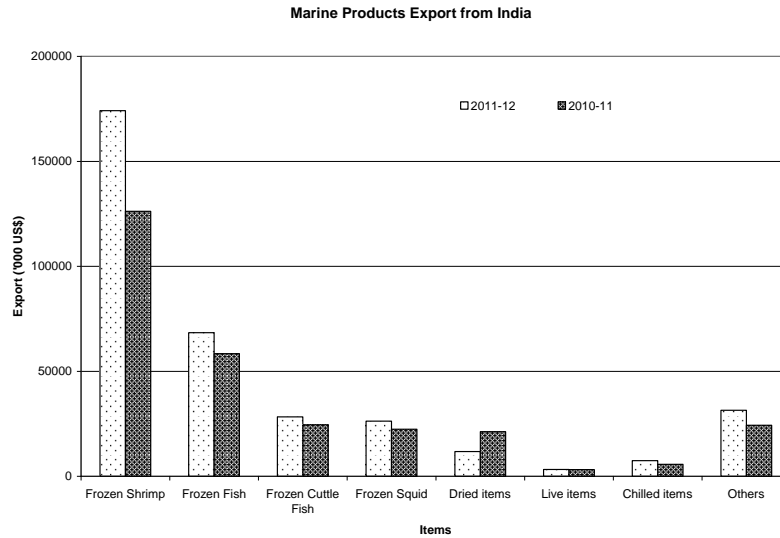


Fig. 2: Marine Products Exports from India

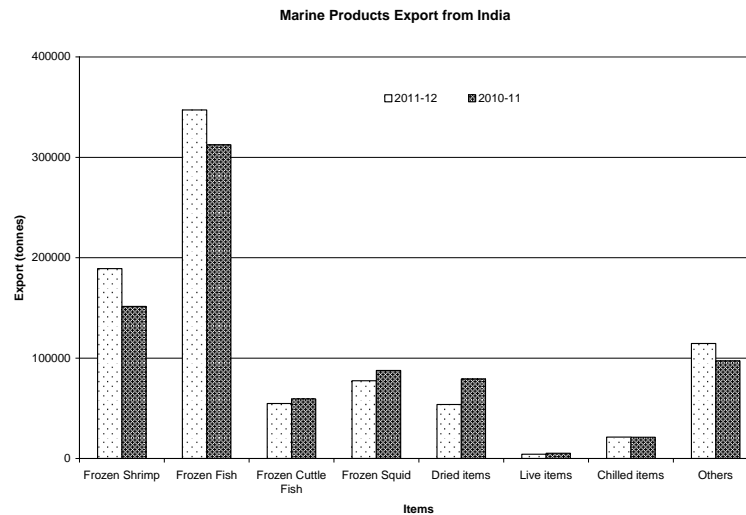


Fig. 3: Marine Products Exports from India

Major export markets

As per the current status the largest buyer of Indian marine products is South East Asia with 39.9% share in volume and 25.09% share in value (US\$). The next highest buyer is European Union with 22.96% share in volume followed by USA 18.17%, Japan 13.01%, China 7.51%, Middle East 5.33% and 7.5% to other countries. Export to South East Asia recorded a growth of 45.01% in volume and 87.51% in US\$ realization. This is mainly due to the increased export of Frozen Shrimp, Frozen Fish and Chilled items. Exports to United States registered a growth of 36.45% in quantity and 45.39% in value (US\$ realization) and this is mainly due to increased export of Frozen Shrimp and cephalopods.

Exports of Vannamei shrimp showed a tremendous increase in US market by 212 % in quantity and 209% in US \$ realization. Export to Japan also registered a positive growth of 21.33% in quantity and 22.35% in US \$ terms. Exports of chilled items showed a tremendous increase in Japanese market by 120.12% in quantity and 220.34% in US \$ realization. Exports to China showed a drastic decline of 46.89% in quantity and 40.17% in US\$ terms. The marine products exports have strengthened India's presence in South East Asia. There is a significant increase in exports to South East Asian Countries compared to the previous year. Export of Fr. Shrimp to South East Asia has registered a growth of about 222.43% in volume and 356.36% in US\$ terms. Export of Fr. Shrimp to USA has also showed a growth of about 47.68% in volume and 47.55% in US\$ terms. Export of Vannamei shrimp had also picked up. We have exported about 40787 MT of Vannamei shrimp during this period. Export to Middle East countries showed an increase of 25.98% in US\$ realization but declined in quantity by 13.25%. The details are given in the following table.

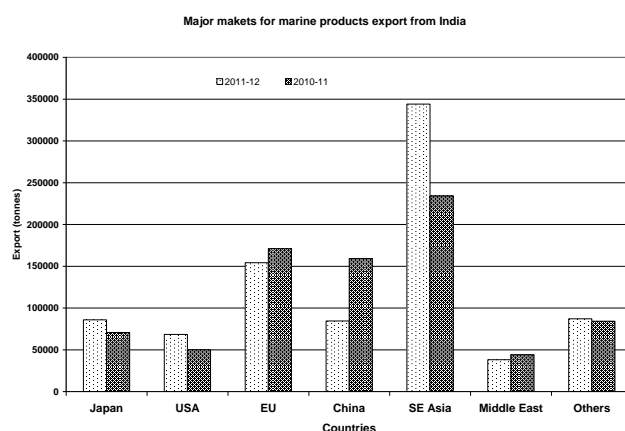


Fig. 5: Major Markets for marine products export from India

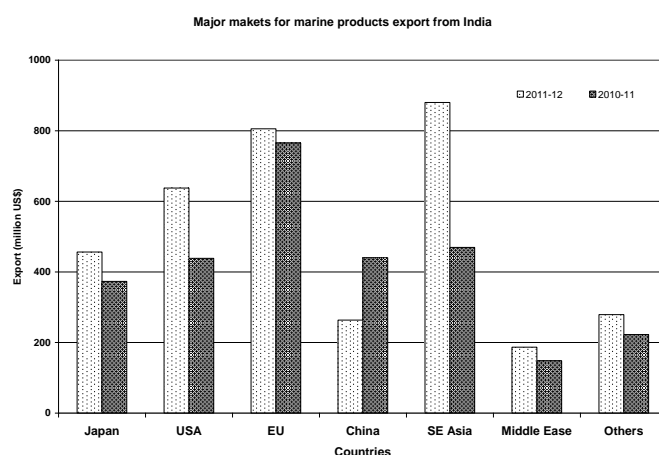


Fig. 6: Major Markets for marine products export from India

Status of Molluscan Fisheries of India

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Introduction

Molluscs are a fascinating and varied group of animals and although their outside features may vary greatly in form and colour, their internal structure are constant. The invertebrate phylum Mollusca with more than 80,000 species is second only to Arthropoda in number of species.

In India, the molluscs contribute to important fisheries, providing nutritious food, and are also foreign exchange earners to the country. The shell has many industrial uses and is the object in making eye-catching articles by deft craftsmen. Men, women and children participate in fishing molluscs, which provide employment and income in coastal rural areas.

Magnitude of Molluscan Fisheries in India

Cephalopods are by far the most important group with an average annual production of about 1,05,000 tonnes (see Fig.1). They are landed as by-catch and as a targeted fishery mostly in mechanized trawlers operating up to 200 m depth, and beyond in some areas. Next in importance are the bivalves and fishing is pursued as a small-scale activity, mostly at subsistence level in various estuaries and inshore seas. The annual average clam production is about 57,000 t, oysters about 18,800 t, and marine mussels about 14,900 t (see Fig.2). There was no fishery for marine pearl oysters since 1962 in the Gulf of Mannar area, which earlier supported major fisheries.

Scallops occur in stray numbers and do not form a fishery, while the windowpane oyster was of considerable fishery value till a few years back. Among gastropods, the chank is most important with annual production of over 1,000 t till a few years back (see Fig.3 for production details). The fishing for top shell (*Trochus* sp) has been banned as they have been declared as endangered. Abalones occur in stray numbers and are not fished. Mining

for subsoil shell deposits for industrial purposes is a major activity in the Ashtamudi and Pulicat Lakes.

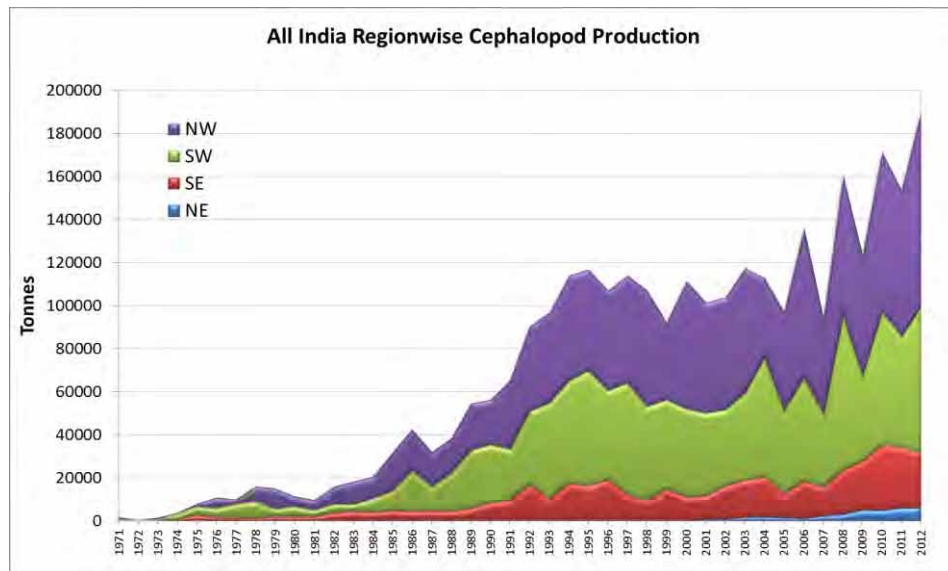


Fig.1: Region wise estimated cephalopod production from Indian seas during 1971-2012. Note the overall dominance of northwest and southwest coasts.

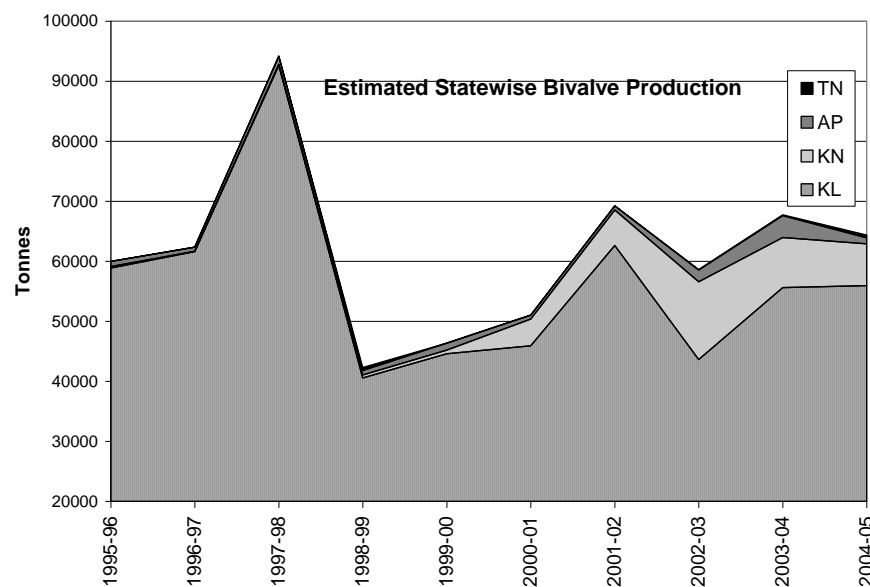


Fig.2: Estimated state wise bivalve production in India. Kerala dominates bivalve production, which includes oysters, mussels and clams. However unlike cephalopod production estimate which is based on a scientifically valid methodology; the estimates for bivalve production is mostly region specific, and therefore, the error of the estimates are likely to be high.

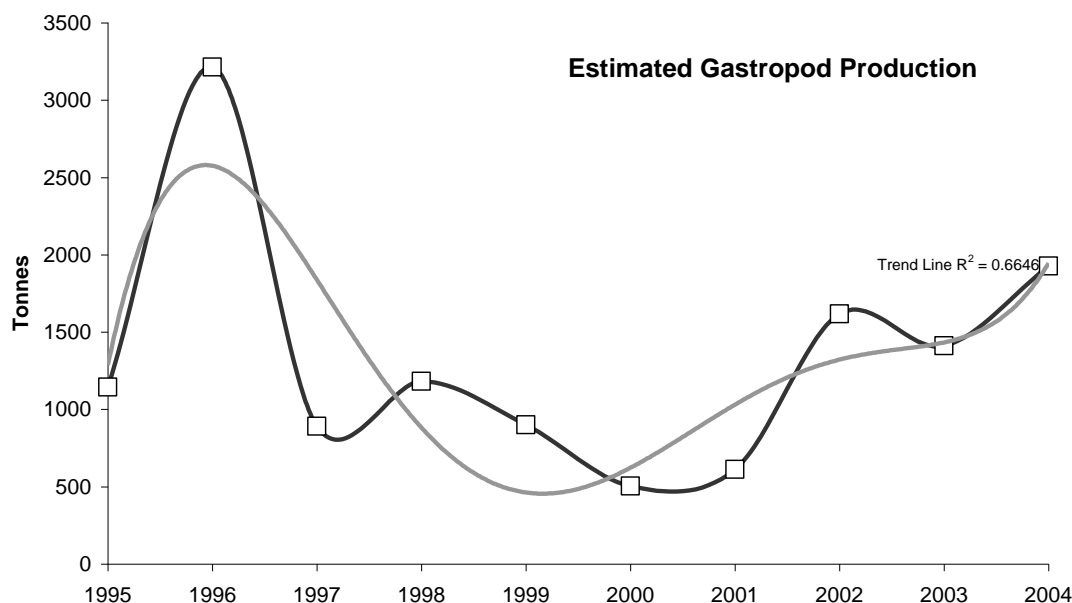


Fig.3: Estimated annual gastropod production in India along with trend line. TN and KL states contribute to almost all of the production. These estimates are likely to be gross underestimates due to low taxonomic resolution of the data set.

Bivalve Fishery

A variety of clams, oysters, mussels and the windowpane oysters are distributed along the Indian coastline where they are fished by the local people. Clams and cockles form 73.8%, followed by oysters (12.5%), mussels (7.5%) and windowpane oysters (6.2%). The major bivalve resources and their total landing are given in Table.1 and Fig.2. The production levels in other states are meagre. Information on the bivalve production from the NE and NW states are scanty.

Utilization

India has been exporting bivalves especially clam and mussel meat to other nations (Fig.4). The average foreign exchange earned by the nation during 1991-2003 through bivalve and gastropod exports is Rs.13 crores from the export of 1998 t of various products like frozen, smoked and dried meat and seashells. Bivalves fished along the West Coast are utilized for human consumption. Some bivalve products like smoked and canned oysters have good market in Indian metro cities. In Kerala and Andhra Pradesh part of the clam landings are used as a major ingredient of shrimp feed. The extensive shrimp farms also use dried and boiled clam meat as shrimp feed. Apart from these, the shells of bivalves are used in the manufacture of cement, calcium carbide, sand-lime bricks and lime. The lime shell is used as manure in coffee plantations, as mortar in building construction, in the treatment of

effluents, as a pesticide by mixing with copper sulphate and in glass, rayon, polyfibre, paper and sugar industries. Bivalve shells with attractive sculpture are used by the ornamental shell craft industry. The shells of giant clams, winged oysters and black lip pearl oysters are used as curios in the Island territories.

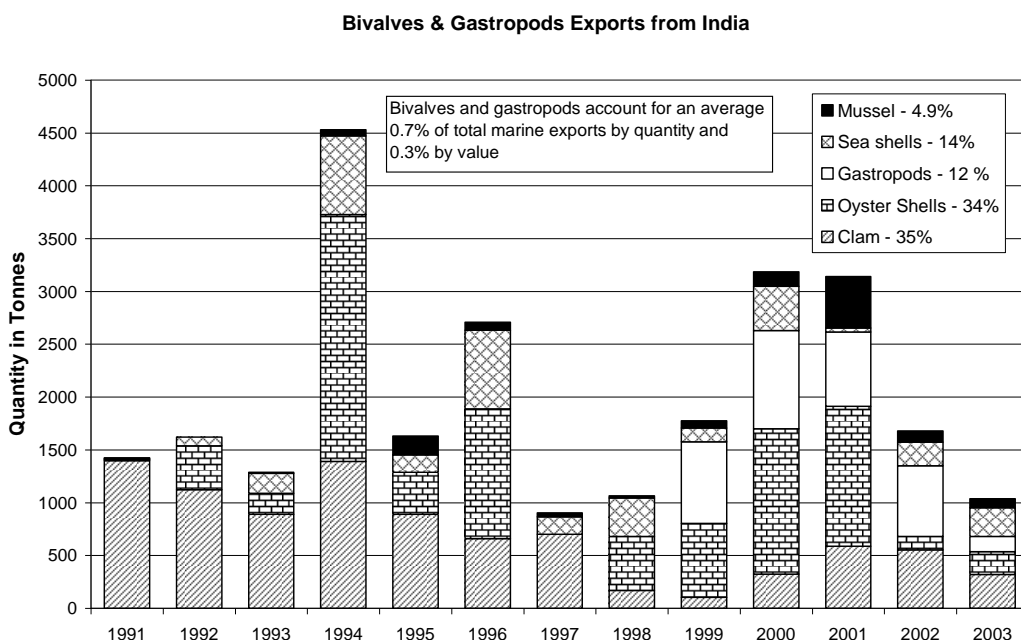


Fig.4: Export of bivalve and gastropod products from India. Major contributors are clams and oyster shells. There is great scope for increasing the quantity and value through product diversification and addressing niche markets. (Data source: MPEDA, Cochin)

Stock assessment

Only few studies have been made to assess the stock of bivalves. However, short term surveys have been conducted in the estuaries and coastal regions of maritime states to study the standing stock bivalve resource. Using the standing stock estimates by CMFRI the potential yield of bivalves has been estimated (Table.1). The present status shows that the clam and oyster resources are underutilized in Gujarat and Maharashtra and effort to utilize these resources should be enhanced. However bivalves have varied reproductive potential hence these resource estimates have to be revalidated frequently. In other states like Kerala and Karnataka the resources are utilized and in some regions they require conservation.

Table 1. Standing stock and potential yield estimates of bivalves

Resource/ State	Estimated standing stock	Potential Yield Estimate
<i>CLAMS AND COCKLES</i>		
Maharashtra	4000	5000
Goa	1200	2000
Karnataka	8027	6823
Kerala	65000	55250
TN & PON	5770	4905
Andhra Pradesh	58000	49300
TOTAL	141997	123278
<i>OYSTERS</i>		
Gujarat	1500	1050
Maharashtra	335	235
Karnataka	450	315
Kerala	4200	2940
Tamil Nadu	19032	13322
Andhra Pradesh	23000	16100
TOTAL	48517	33962
<i>MUSSEL</i>		
Maharashtra	1800	1260
Goa	1120	784
Karnataka	9800	6860
Kerala	17473	12231
Tamil Nadu	350	245
Andhra Pradesh	1000	700
TOTAL	31543	22080
<i>WINDOWPANE OYSTERS</i>		
Gujarat	5000	3500
Goa	120	84
Andhra Pradesh	12420	8694
TOTAL	17540	12278
GRAND TOTAL	239597	191598

Management Strategies

Bivalves offer one of the important examples of marine resource management along the Indian coast. However, apart from the restriction on the pearl oyster fishery by the Government of Tamil Nadu, and the management measures on the short-neck clam fishery of Ashtamudi Lake, Kerala, there are no regulations for effective utilization and conservation of these sedentary marine resources. One of the major bivalve resources, the short-neck clam (*P. malabarica*) is well protected by the following regulations formulated by the Government of Kerala based on recommendations made by CMFRI. a) Ban on fishing

activity during breeding season (September to February), b) use of gears with 30 mm mesh size to avoid exploitation of smaller clam, c) Restrict the grade of export of frozen clams meat to 1400 nos/kg and above and d) Initiate semi-culture or relaying of small clams.

One of the major drawbacks in bivalve fishery management is that there is no proper data collection system on the fishery landings. A proper database on the resource availability and their utilization pattern is essential.

Ashtamudi Lake Clam Fisheries Management Plan

- Part of Zone I, under and west of the Neendakara Bridge should be declared as a no-take zone for clams all through the year. This will function as a protective zone where in regenerations of stocks will take place continuously and this will also help re-populate clams in other zones. This zone can function as a **CLAM SANCTUARY**. The provision of **Declared Fisheries Zone (DFZ)** of the Kerala Inland Fisheries Act may be invoked for this purpose by the State.
- **Seed clams can be transplanted and cultured** in shallow areas having similar water and sediment conditions of the clam beds. The suitable areas for such transplant culture are indicated in the report of Suja (2012) and an example GIS map is shown below (Fig.9). The optimum stocking densities are also indicated in this report.
- Seed clams below 20 mm APM should not be allowed to be harvested, and if harvested, they should be relayed. This size may be declared as the **Minimum Legal Size (MLS)** for harvest by the DOF.
- As a long-term conservation measure, hatcheries have to be developed within the next 10 years for breeding the clams and spats can be relayed in suitable locations (indicated above) in Ashtamudi Lake.
- **Transplantation of clams** from one estuary to another must not be permitted as the ecological effects cannot be easily judged beforehand. No species introductions should be permitted in Ashtamudi Lake without a comprehensive study by a research institute and permission of the SFD.

Ashtamudi Lake – A managed Clam Fishery

The short-neck clam fishers (numbering about 500 fulltime and part time fishers) of Ashtamudi Lake are perhaps one of the best examples of a well managed local fishery benefiting the fishers and maintaining sustainable harvests. The management practices are implemented by the cooperative societies with the active scientific support of CMFRI.

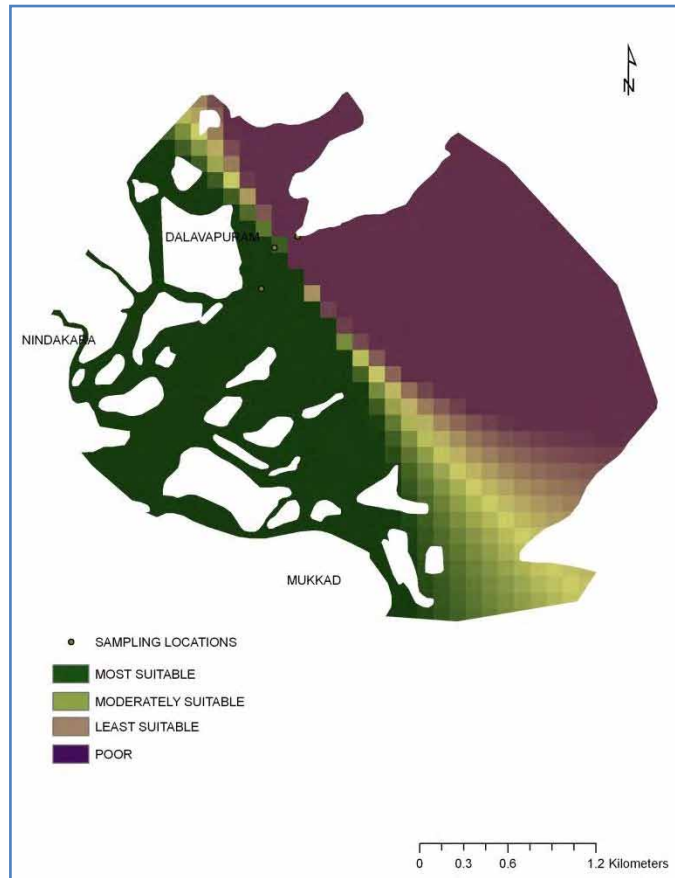
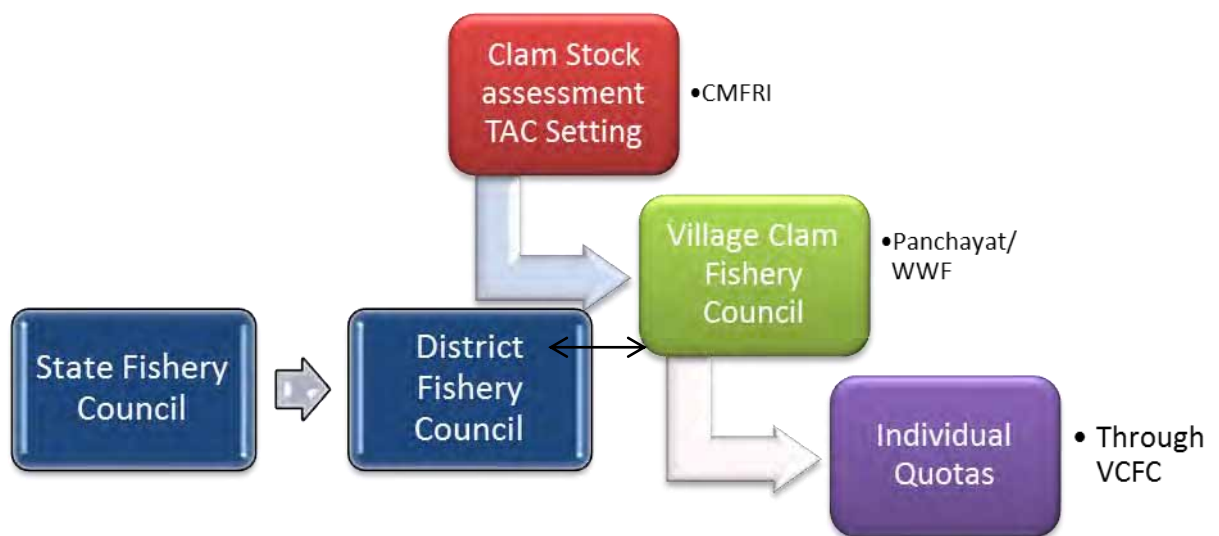


Fig. 4 : GIS map showing areas suitable for clam transplantation (farming) in Ashtamudi Lake. From Suja (2012)

- A system of **licensing of clam fishers** in the Lake and registration of boats and gears used for clam fishing should be urgently carried out by the SFD.
- **No mechanical devices** should be permitted for the harvest of clams in the Lake.
- The CMFRI should conduct clam biomass surveys in Jan-Feb every year, and come out with estimates of fishable stock in the ensuing season. The CMFRI should provide sufficient information to generate a **Total Allowable Catch (TAC)** which can be later converted to individual quotas for fishers on an annual basis.

- For effective management of the clam resources of the Ashtamudi Lake, a stakeholder council or **Village Clam Fishery Council (VCFC)** should be formed by the administration. This council should have representation from panchayat, Department of Fisheries, CMFRI, NGO's working in the area and clam societies. They should meet once in a quarter. The Council should have powers to debate and formulate rules as necessary for effective management of the clam fisheries.
- Following the participatory mode 3-tier fishery management system, the VCFC should report to the District Fishery Council (DFC) and ultimately to the State Fishery Council (SFC). The modalities of such a management regime should be enunciated by the DOF.



- The southern and northeastern parts of the Ashtamudi Lake are currently devoid of clam populations. It was not so many years ago. This has happened due to **deterioration in water quality** in these regions through increased urbanization and unregulated waste dumping. This part of the Ashtamudi Lake needs special focus to improve the habitat quality for ecological sustainability of the Lake.
- Zones I to V as demarked in the map may be declared as **Clam Management Area (CMA)** of Ashtamudi Lake by the DOF for the purpose of framing necessary rules and regulations to govern the clam fisheries by the VCFC.
- **Depuration of clams** for hygienic consumption may be encouraged. This could be done by the fishers or processors or agents. A scientific

depuration and meat shucking process has been developed by CMFRI and this may be initially financially supported by the DOF as a scheme.

Cephalopod Fishery

Cephalopods are a marine fishery resource of increasing importance and many species are exploited as by-catch by trawlers from throughout the Indian coast. Although they form only 4-5% of the total marine fish landings, cephalopod stocks are under heavy fishing pressure because of their high value as an exportable commodity. So much so, of late, they are even targeted by the trawl fleet in certain seasons of the year along parts of the west coast of India. The CMFRI has initiated studies on cephalopod stock from Indian waters during the seventies. The initial results of this programme on the taxonomy, biology, fishery and stock assessment of cephalopod stocks pertaining to the seventies were published as a bulletin. Subsequently a major exercise on the stock assessment of Indian cephalopod stocks with data of 1979-89 was made by CMFRI. These studies indicated that squids were exploited at optimum level on both coasts and cuttlefishes were optimally exploited along east coast and under exploited along west coast.

Exploited Cephalopods

Cephalopods exploited from Indian seas can be broadly divided into three, viz., squids (order Teuthoidea), cuttlefishes (order Sepiioidea) and octopuses (order Octopodidea). A list of neretic species commercially exploited is given in Table 2. The dominant species occurring in commercial catches are *Loligo duvauceli*, *Sepia pharaonis*, *S. aculeata* and *Octopus membranaceus*.

Table 2: List of commercially exploited cephalopods from Indian Seas (some taxonomic names have been changed)

Species	Common Name	Distribution
Squids		
<i>Loligo duvauceli</i>	Indian squid	All along Indian coast
<i>L. uyii</i>	Little squid	Madras & Visakhapatnam
<i>Doryteuthis sp</i>	Needle squid	SW and SW coast
<i>Loliolus investigatoris</i>	Investigator squid	All along Indian coast
<i>Sepioteuthis lessoniana</i>	Palkbay squid	Palk bay & Gulf of Mannar
<i>Symplectoteuthis oualaniensis</i>	Oceanic squid	Oceanic Indian EEZ
<i>Thysanoteuthis rhombus</i>	Diamond squid	Oceanic Indian EEZ
Cuttlefishes		
<i>Sepia pharaonis</i>	Pharaoh cuttlefish	All along Indian coast
<i>S. aculeata</i>	Needle cuttlefish	All along Indian coast
<i>S. elliptica</i>	Golden cuttlefish	Veraval & Cochin
<i>S. prashadi</i>	Hooded cuttlefish	SW & SE coast

<i>S. brevimana</i>	Shortclub cuttlefish	Madras & Visakhapatnam
<i>Sepiella inermis</i>	Spineless cuttlefish	All along Indian coast
Octopuses		
<i>Octopus membranaceous</i>	Webfoot octopus	SW & SE coast and islands
<i>O. dollfusi</i>	Marbled Octopus	SW & SE coast and islands
<i>O. lobensis</i>	Lobed octopus	SW & SE coast and islands
<i>O. vulgaris</i>	Common octopus	SW & SE coast and islands
<i>Cistopus indicus</i>	Old woman octopus	SW & SE coast and islands

Methods of Exploitation

Although about 40% of the world's cephalopod catches are taken by squid jigging and 25% by trawling, in India, cephalopods are principally caught by bottom trawlers operating upto 200m depth zones. While most of the catch is brought in as by-catch from the shrimp and fish trawls employed by the trawlers, of late, there is a targeted fishery for cuttlefishes during the post monsoon period (Sep-Dec) using off bottom high opening trawls along the SW and NW coast. Prior to the seventies traditional gears like shore seines, boat seines, hooks and lines and spearing were the principal gear employed to capture cephalopods. These traditional gears continue to be used especially for cuttlefishes at Vizhinjam, where there is no trawl fishery. Experimental squid jigging has been tried with Japanese expertise along the west coast by GOI vessels with considerable success. However, commercial squid jigging is not practised in India.

Cephalopod Production

Cephalopod production, which remained at very low level upto the early seventies, has shown a remarkable increase crossing the 100,000 tonne mark in 1994 (Fig.1). From 1973 onwards the commencement of export of frozen cephalopod products to several countries saw the transition of the resource from a discard to a quality resource fetching high foreign exchange. Thereafter its production showed a steep increase (Fig.1). The west coast maritime states, Gujarat (GUJ), Maharashtra (MAH), Goa (GOA), Karnataka (KAR) and Kerala (KER) contribute to the bulk (86%) of the production. While the production from the east coast amounts to only 14%, of which, Tamil Nadu (TN) contributes the maximum followed by Andhra Pradesh (AP). The states of West Bengal (WB), Orissa (OR) and Pondicherry (PON) contribute only a small percentage. Overall, KER ranks first contributing a third of the all India production followed by MAH, GUJ and KAR.

At the national level, Jan-Mar and Oct-Dec were the most productive period. Along the upper east and west coast, the above months were the most productive, while in KAR, KER, TN and AP Jul-Sep was also equally productive.

Utilization and Marketing

There is very little internal market demand for cephalopods and consequently almost all the catch is exported. Export of cephalopods from India during 1991 to 2003 is shown in Fig 5. While the quantity peaked in 1995, when cephalopods formed about the 45% of the total quantity exported, the annual average is about 24%. However, the value of cephalopods in total marine exports has remained at 15% from 1992 onwards without much variation. In 2006 the value of cephalopods exported amounted to more than Rs 1000 crores. Category-wise, squid products are the maximum in all years followed by cuttlefish products. The products include dried, frozen whole, filleted, tentacles, rings, roe, wings, IQF and bones and ink. Octopus products exported are meagre, but from 1994 onwards there is rising trend in its exports. The main markets for export of Indian cephalopods are Europe, Japan and China.

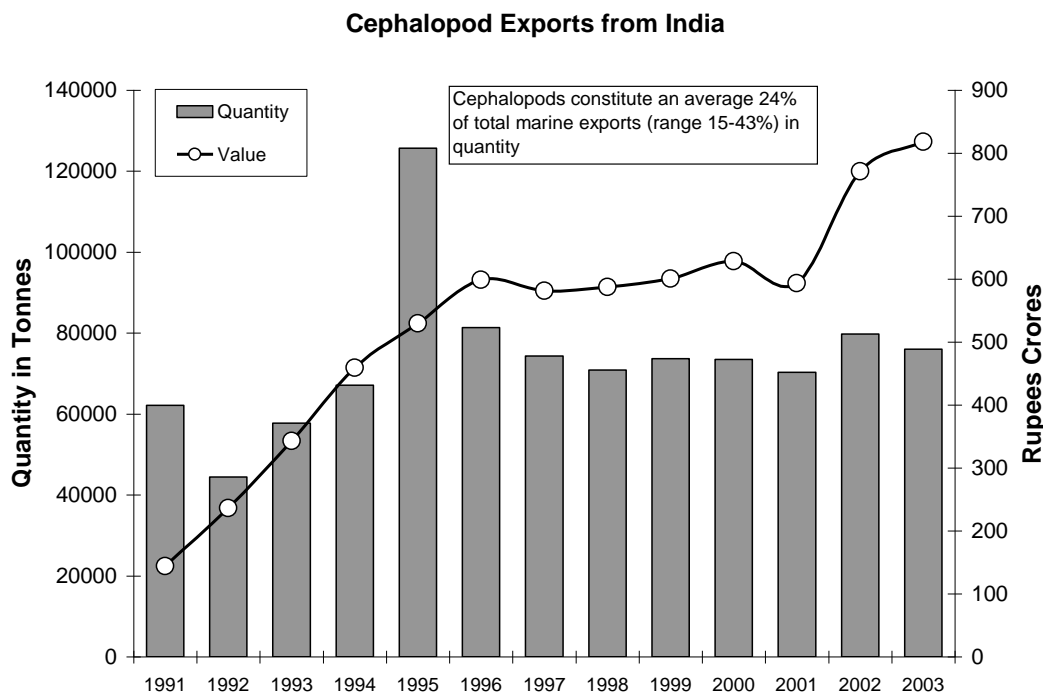


Fig.5. Trend of cephalopod exports from India in terms of quantity and value. Although the quantity exported has remained steady at around 75,000 tonnes, the value has shown a consistent increase in recent years. (Data source: MPEDA, Cochin)

The emergence of cephalopods as an important marine fishery resource of the country with almost cent percent export potential warrants careful monitoring and appropriate management particularly because we are exploiting above the revalidated potential yield of 101,000 tonnes. Several gaps exist in our knowledge of these valuable resources, especially on the life histories of our species. For example, we still have not resolved the question of semelparity of most of our species. At present we know that most

of the species lay their eggs in the shallow inshore waters. These grounds are subjected to sedimentation due to man-made causes such as dumping of sludge. This might degrade the benthic conditions with a negative impact on cephalopod egg laying and consequently on the recruitment.

Gastropod Fishery

The exploitation of gastropods in India is age-old for both as food and as curios. The famous money cowries used as currency and the religious sentiments attached to the sacred chank are well known. The gastropod biodiversity in Indian waters is very large and no systematic effort has been made to document this qualitatively and quantitatively, apart from few works. Considering the intense exploitation of these shelled animals in certain areas of the country as a raw material for the shell-craft industry, a number of these ornamental molluscs have been declared as endangered and are protected under the Indian Wildlife Protection Act.

Chank Fishery

Chanks (*Xancus pyrum*) are fished mainly for the shell and an organised fishery of considerable magnitude exists along the southeast coast of India. They are also collected at a few other places along the Indian coast.

Major chank resources occur in the Gulf of Mannar, particularly along the Ramanathapuram – Tirunelveli coast. Other areas are Tanjavur, South Arcot and Chingelpet in Tamil Nadu, Trivandrum coast in Kerala, the Gulf of Kutch in Gujarat and the Andamans. Unlike pearl oysters, the chanks are regularly fished with few exceptions.

The estimated the average annual chank production in India at 12,56,000 chanks comprising 8,77,000 from Tirunelveli coast, 3,00,000 from Ramanathapuram coast, 40,000 from Thanjavur – South Arcot – Chingelpet coast, 22,000 from Kerala state, 12,000 from the Gulf of Kutch and 5,000 from the Andamans. In terms of weight, chank production would be 1250 t/year (see also Fig.3).

Whelk Fishery

The whelks come under the order Neogastropoda and family Buccinidae. They are mostly carnivorous and scavengers. The meat is edible and the shell is used in the shell craft industries. In India, two species namely, *Babylonia spirata*, and *B. zeylanica* are landed as by-catch, mostly in the bottom trawls. The former species is more abundant and most of the production is exported. Except for some fishery data in the by-catch of shrimp trawls, no information seems to be available on *B. zeylanica*.

Fishery for ornamental gastropods

There are several economically important species of gastropods which are regularly collected for meat / and or shell. They come under many families, extensively used in shell craft industry and are popularly called as ornamental gastropods. Many of them live in coral reef habitat in regions such as the Gulf of Kutch, Gulf of Mannar, Palk Bay, Andaman and Nicobar Islands and the Lakshadweep group of Islands.

Future of Molluscan Exploitation

The following are areas of concern with regard to exploitation of molluscs in India:

- ✕ Exploitation of cephalopods above the potential yield estimate and localized over-exploitation of stocks
- ✕ Oceanic cephalopod potential to the tune of 20-50,000 t which are yet to be exploited
- ✕ Grossly under-reported catches of bivalves and gastropods
- ✕ No major studies in the country on bivalve and gastropod biology and no information on the magnitude and economics of the shell-craft industry
- ✕ Conservation and stock rebuilding strategies with respect to endangered molluscs are not in place

In the light of this, it is important to determine the science, management and institutional requirements needed to obtain the tremendous potential value from molluscan resources to the country and to make a path for sustaining molluscan fisheries and rebuilding protected species stocks to realize their long-term potential.

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Marine Biodiversity of India- A Perspective for RFM

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Introduction

The convention on Biological Diversity (CBD) recommends the conservation of ecosystem through policies for protected areas and sustainable management. Excerpts from the Article 8 of the Convention on Biological Diversity: In situ conservation, which promote the protection of ecosystem and the maintenance of viable populations of species in natural surroundings. In India we had several species of organisms belonging to different groups constitute the protected marine organism and majority of them are belonging to elasmobranchs, dolphins, whales, sea cow, turtles, molluscs, corals, sponges holothurians and gorgonids. India is blessed with rich biodiversity along the west and east coast resulting in the supply of essential ecosystem goods and services to the millions of population living in the coastal area. Vast regions of mangroves are found along the coast of West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Maharashtra, Gujarat and Andaman Islands which extends up to about 682000 ha area. Coral reefs are found in the Gulf of Kutch, along the Maharashtra coast, Kerala coast, in the Gulf of Mannar, Palk Bay and the Wadge Bank along the Tamilnadu coast and around Andaman and Lakshadweep Islands (Devaraj *et al.*, 1998). The variety of coastal ecosystems include brackish water lakes, lagoons, estuaries, back waters, salt marshes, rocky bottom, sandy bottom and muddy areas provides a home and shelter for the mega biodiversity of India. These regions support very rich fauna and flora and constitute rich biological diversity of marine ecosystems. The long coastal line of 8129 Km² with an EEZ of 2.02 million Sq. km including the continental shelf of 0.5 million Sq. Km are not only rich in marine biodiversity but also faces several threats to biodiversity from various sources (Joshi, 2012). Most of these regions face serious threats due to increasing human population increase and resulted human interventions characterized by pollution, deforestation, over exploitation of marine resources, dredging, quarrying and other activities leading to environmental degradation.

The marine and coastal biodiversity conservation and protection mainly depends on the knowledge of the taxonomy of the flora and fauna constituting the biodiversity and the

species interaction in the ecosystem. Due to the inherent complexity of taxonomy and change of research priority in the marine fisheries sector during the recent years have resulted in the shortage of taxonomic experts in the case of a major marine organism like fin fish and ancillary organism like coelenterates, sponges, echinoderms and others. It is well known that taxonomic information offers an interesting connection between the economic and ecological studies on biodiversity measurement. If nothing else, taxonomic data are informative and the information has got great significance in marine biodiversity conservation. Several studies that revealed how the taxonomic information can be utilized for prioritizing conservation spending. The systematic information assumes the existence of complete taxonomic lineages for the species of interest as well as an understanding of the extent to which a successful intervention can reduce extinction probabilities of species in the branches at a given time (Faith *et al.*, 2004). Taxonomic research is extremely data demanding and comprehensive taxonomic information is not available for most of the species and the precision of such weighting exercise is limited by the cost of collecting data. Monitoring cost and decision urgency are issues when considering any level of biodiversity management. The higher order of classification like species richness, landscapes, distribution pattern are less costly to identify and monitor but offers less precision in terms of their approximation of lower level diversity (Faith and Basker, 2006). In general characters like ocean scapes, coastal classes, species assemblage, higher tax and species offer less cost for measurement but at the same time offer low precision. The genetic complementary data, phylogenetic tree assemblage offers high precision but needs higher monitoring cost. Considering these the present attempt is to review the status of different marine ecosystems and flora and fauna with reference issues and challenges concerned with marine biodiversity of India.

1. Status of Marine ecosystems

The topographical features nature of the continental shelf and the distribution pattern of fish and shellfish diversity in the coastal region as well as in the Exclusive Economic Zone (EEZ) varies from region to region along the Indian coast. Earlier studies on the physical, chemical and biological oceanography of the seas around India have shown that inshore waters (0-50 m) are relatively more productive. As we know the large scale upwelling during south-west monsoon off the west coast of India and the strong convergences developing along the east coast of India and Andaman sea during the northeast monsoon, the change in the current pattern from season to season and the seasonal distribution of thermocline, Phyto and zooplankton biomass greatly influences the marine fisheries in different regions of the coast (Devaraj *et al.*, 1998).

Diversity in the species complex, typical of tropical waters and co-existence of different fish and shellfish species in the same ground are important features of Indian Marine Biodiversity. Past studies on the biological and fishery characteristics of the important groups shown that most of the species supporting the fishery are short lived with an average life span up to 3-5 years, but the fishery being mainly supported by under an year olds and one year old. They are highly fecund and spawn over longer periods mostly with fractional spawning and show wide annual variation in recruitment. Several issues in the captive fisheries sector adversely affect the marine biodiversity of the country especially in the fish as ecosystem good for human beings. The issues such as limitations of growth

and production in the inshore fishing grounds, less profitability and economic returns due to increased cost of fishing operations, management problems in the context of common property multigear, multispecies nature of fisheries (Devaraj, 1996). The above issues brought about by the uncontrolled fishing effort put into the fishery without any regard to stock-production-recruitment relationship. Besides these the ecological problems created by increasing pollution of coastal waters by release of untreated effluents and pollutants by agro industrial complexes operating in the coastal zone. It has been observed that the sediment in certain waters contains high levels of Copper, Zinc and Lead. The mercury content in some of the marine organisms in certain places has been found to be higher than the normal which may alter the genetic makeup of a species. The fly ash deposits from thermal plants in certain places changing with the increase and its the bottom topography of the affected area and chances of species depletion and replacement. To address these issues a thorough knowledge about different marine ecosystems like mangrove ecosystems, coral reef ecosystem, estuarine ecosystem, coastal marine ecosystem, lagoon, systems, coastal ecosystems and marine protected areas of India is a prerequisite.

1.1 Mangrove ecosystems: A large number of Islands along the Indian coast in the Gulf of Mannar, Gulf of Kutch, Lakshadweep and Andaman group and the vast mangrove ecosystems along the coast of Goa, Karnataka, Kerala, Tamilnadu, Andhra Pradesh and West Bengal constitute rich marine biodiversity supporting a variety of species of corals, sponges, ornamental fishes, crustaceans, mollusks and plants. The diversity of the species provides several ecological services like shoreline protection, sea erosion, larval dispersal, breeding and larval rearing and safe habitat for migratory species for the ecosystem. Indiscriminate fishing, quarrying, dredging, deforestation, industrialization and other anthropogenic activities are the main threats causing considerable damage to these environments and consequently to the associated flora and fauna (Gopinathan and Selvaraj, 1996, Kathiresan and Rajendran, 2005).

Mangroves are good breeding and nursery grounds for a variety of prawns and fishes. It provides nutrition for various organisms through recycling of plant and animal remnants. Mangroves give protection to the coastline from natural disasters like Cyclone, flood and Tsunami (Gopinathan and Selvaraj, 1996). Mangrove ecosystem provides opportunities for boating, hunting, bird watching, wildlife observation, education trips for specimen collection and photography. Apart from these capture and culture fishery activities in many coastal regions are dependent on mangrove dominated estuaries. Some of the endangered and vulnerable species associated with Indian mangroves are Dugong (*Dugong dugon*), the Bengal tiger (*Panthera Tigris tigris*), Smooth-coated otter (*Lutrogale perspicillata*), Fishing cat (*Prionailurus viverrinus*), Sambar deer (*Rusa unicolor*), Hawksbill turtle (*Eretmochelys imbricata*), King cobra (*Ophiophagus Hannah*), Sharp tooth Lemon Shark (*Negaprion acutidens*) and Mangrove Whip ray (*Himantura granulate*).

1.2 Coral reef Ecosystems: India is blessed with vast stretches of coral reefs in the Gulf of Mannar and Palk Bay, Gulf of Kutch, South-west coast and along the Andaman and Lakshadweep islands. Coral reefs are the most biologically productive and diverse of all natural ecosystems. Reefs are equivalent to tropical rain forest for their rich biological diversity. Corals have many uses like recreation, tourism and shore limp protection. Coral reefs are huge amounts of calcium carbonate which forms the raw material for many lime

waste industries, cement and calcium carbide. They are also used as building blocks in many parts of India. The fin fish fauna of coral reefs are extremely rich and diverse. Besides they are raw materials for industries such as cement, lime and calcium carbide. About 225 species of corals are known from the Indian seas (Pillai, 1996). Indiscriminate exploitation of the corals, dredging the reef areas and the exploitation of the reef flora and fauna has resulted in the destruction of coral reefs of India. The coral reefs of India face several threats from both natural and anthropogenic origin. Indiscriminate exploitation of corals for various purposes, over exploitation of reefs associated living resource, dredging, reclamation, are important anthropogenic factors in the destruction of corals in India. Pollution, sea erosion, siltation, constructive activities in lagoons also added to this man made cause of destruction of reefs. Global warming, coral bleaching, cyclones, pests like *Acanthaster planci*, white band diseases are some of the natural cause affect mortality of corals.

1.3 Estuarine ecosystems: Estuary is a partly enclosed coastal body of brackish water with one end rivers flowing into it and the other end open to the sea. Estuaries are important buffer zones as it is a transition zone between freshwater environments and are subject to marine influences such as tides, waves and influx of saline water, fresh water and sediment. This inflow of both marine and fresh water brings lots of nutrients in both water and sediment makes them most productive habitats in the world. A total of 14 major, 44 medium and 162 minor rivers draining fresh water into the sea through about 53 estuaries in India. Several of Indian estuaries have become danger prone zones (Alok Saxena, 2012). Estuaries are the natural nurseries for many marine animals but their fisheries have declined due to over exploitation of juveniles and anadromous stocks. Estuaries face threats are damming of rivers, construction of barrages, fishing pressure, and pollution are the main cause for biodiversity loss and degradation of the ecosystem. Estuaries face problems of lack of effective planning and coordinated among the different stakeholders in the implementation of management option, lack of critical knowledge on the ecological principles as well as sustainable management of resources, and low level of knowledge on the biodiversity value of goods and services provided by estuary.

1.4 Lagoon Ecosystem: A lagoon in a shallow water body along the low lying coast separated from the ocean by a barrier and also connected to the sea by inlets or estuary at one or two places. A total of 17 major lagoons or lakes occur along the coast of India. Important lagoons are Chilka Lake, Gulf of Mannar, Muthupet, Muthukkadu, Nizampatanam, Pennar, Pulikat Lake, Ashtamudi Lake, Ettikulum, Paravur Lake, Murukkanpuzha, Talapdy, Veli Lake, Vembanad Lake, Lagoons of Bombay, and Lakshadweep atolls (Alok Saxena, 2012). The lagoon ecosystems are the most vulnerable ecosystems due to several anthropogenic activities which threatens flora and fauna of the system. Threats include pollution from industries, dumping of city sewages, recreational boating, navigation, dredging, expansion of urban and rural settlements, reclamation, over exploitation of fish stocks, intensive aquaculture practices and pollution from different sources.

Diversion of lake water for use in irrigation and industry, invasions of plant and animal exotic species, and contamination by toxins and nutrients from industry, farms, sewage and urban runoff are the threats to the existence of lake ecosystems of India. In most parts of the world anthropogenic impacts on lakes are spreading geographically and becoming more intense in quantity and quality due to human population increases and the globalization of trade, which has increased deforestation and the use of pesticides and fertilizers, and has spurred the spread of invasive species. Lakes and lagoons that often fringe them provide critical wintering; feeding, resting and breeding habitat for many species of migrating birds, yet one of the largest gaps in biodiversity assessments to date has been bird diversity. One factor not regularly included in assessments of lakes is the present and future degree of water scarcity in the watershed. Water scarcity can be expected to negatively impact lakes due to human reliance on increasing proportions of their water usage for drinking water, irrigation and industrial needs. Chilka and Vembanad lakes are examples of lakes identified using Ramsar criteria that had not been identified by previous prioritization studies. Chilka is a brackish coastal lake separated only by sand flats from the Bay of Bengal, and is home to many important migratory bird, gastropod, bivalve, reptile and mammal populations.

1.5 Coastal Ecosystems: Characteristic features of the Indian Ocean are the upwelling, southwest monsoon, northeast monsoon, mud-bank along the southwest coast and high coastal production. Upwelling occurs in the region between Kanyakumari and Karwar during the onset of southwest monsoon. It starts in the southern region first and then extends northwards with the progress of southwest monsoon. Southwest monsoon season is the period when mud-banks are formed in some places along the southwest coast of India especially the Kerala coast. Mud banks of the Alleppey - region is formed by the subterranean mud and Vembanad lake system provides the mud for this. The mud-banks between Parapanangadi and Tanur are the aggregation of coastal mud. The mud-banks at Chellanam, Narakkal, Valappad, Elathur, Quilandy, Muzhuppilangadi, Kottikalam, Anjur, Adakathubali, Kumbala, Uppala and Ullal are formed by the sediments and organic debris discharged from river and estuaries. Mud-banks at Vypeen are formed from dredging operation (Rao *et al.*, 1992). Along the southwest coast in the India maximum production of phytoplankton takes place during the southwest monsoon months. The optimum hydrographic condition in the southwest monsoon mouths, the salinity of water falls from 35‰ to 30-31‰, the temperature decreases from 31-32°C to 23-25°C and abundance of nutrients like phosphate, nitrate and silicate become abundant due to upwelling and river discharges makes maximum phytoplankton production which is higher than some of the fertile seas of the world.

The peak of plankton biomass is observed during peak southwest monsoon and pre-monsoon periods that is during and after upwelling, while the abundance of fish eggs and larvae shows peak during pre-monsoon. Thus it is well known that the intensity of southwest monsoon plays an important role in the fluctuation of the fishery resources especially the pelagic fishes.

Bay of Bengal is much warmer than the Arabian Sea and more numbers of cyclonic storms develop over Bay of Bengal than Arabian Sea. Seasonal mean surface temperature over Arabian Sea is highly variable from one season to alter as compared to the Bay of

Bengal. The lowest sea surface temperature in the Bay of Bengal was about 25 to 28°C during winter season but in other seasons it remains at 28.5 to 29°C. Bay of Bengal is the one of the world's largest submarine fans which comprised of large volumes of sediments discharged by the Ganges and Brahma Putra Rivers. Bengal basin can be divided into Mahanadi – Godavari and Cauvery off shore basins and non-basinal areas such as Vishakhapatnam – Chilka lake shelf and Madras-Pondicherry shelf. Central Bengal Bay has got an average depth of about 3400 m and several turbidity channels are present with a width of 5 to 27 km. South Bay of Bengal is characterized with the presence of a large number of sea mounts and coral Islands. Sea mounts and coral islands are the excellent habitat for biological diversity with the presence of a variety of marine organisms. They not only provide food and protection but also for the breeding grounds for a large number of organisms. Bay of Bengal shows moderate primary production in all the seasons as compared to Arabian Sea (Devaraj, 1996).

A total of 26 stocks is presently exploited from the inshore waters extending up to 50 meters by mechanized craft using gears like trawls, purse seines, gill nets, hooks and lines and a variety of indigenous crafts and gears. A large number of stocks of them are exploited not only by the same gear but by different gears also. Technological advances, increasing fishing effort, multigear-multiday fishing and higher investments kept the production increasing from about 0.6 million tons in fifteen to about 3.6 million tons in 2010 (Rao, 2013).

1.6 Marine Protected Areas: In India, there are about 31 Marine Protected Areas (MPA) primarily in marine environments, which cover a total area of 627.2 Km² with an average size of 202.1 Km². In order to protect the ecologically important areas Government of India initiated action through the state governments to create a network of MPAs under the Wildlife (Protection) Act, 1972. Recognizing ecological values and importance for biodiversity conservation, the GOI has notified three Biosphere Reserves in 1989 in marine areas *viz*: Great Nicobar Biosphere Reserves in Andaman and Nicobar (885 Km²), Gulf of Mannar Biosphere Reserve (10,500 Km²) in Tamilnadu and Sundarbans Biosphere Reserve (9,630 Km²) in West Bengal (Singh, 2003).

2. Status of Marine Resources

The ecosystem goods and services provided by the fauna and flora and the interrelationship between the biodiversity and ecological processes are the fundamental issues in the sustainability and the equilibrium of the ecosystem. Some of the marine resources like seaweeds, sponges, gorgonids, corals, pipe fishes and others are being exploited for the extraction of pharmaceuticals, active chemicals which are known to cure several diseases. While there are reports of over exploitation of certain of these resources, there are also reports of environmental degradation due to anthropogenic influences. Certain fragile and sensitive marine ecosystems will not be available to the posterity if adequate care is not taken to conserve the system. In order to achieve improved returns while protecting the environment, a suitable policy needs to be formulated to exploit the resources on sustainable levels, to extract the drugs indigenously, basically for domestic use and for limited export. It is seen that there is a tendency for intensive exploitation of exportable commodities, but the country cannot lose sight of the need to protect

biodiversity and meet domestic requirements in its bid to increase foreign exchange earnings. Ecosystem goods from the marine realm included the fin fish crustaceans, molluscs and seaweeds. The important flora and fauna falling to the two major kingdoms such as Animal and Plant Kingdom recorded from the Indian region and their present status are discussed below.

2.1 Kingdoms: Plantae

Mangroves: Mangrove trees up to medium size and shrubs that grow in saline coastal sediment habitats in the tropics and subtropics. Asia has the largest amount (42%) of the world's mangroves (Kathiresan and Rajendran, 2005).

Sea grasses: Sea grasses are flowering plants from one of four plant families (Posidoniaceae, Zosteraceae, Hydrocharitaceae, or Cymodoceaceae), all in the order Alismatales grow in marine, fully saline environments. A total of 14 species of sea grasses in six genera are reported from Indian seas (Venkataraman and Wafer, 2005).

Macro algae (Sea weeds): Macro algae is large multicellular plants that resemble vascular plants but lack the complex array of tissues used for reproduction and water transport. They are found in red (Rhodophyta), green (Chlorophyta) and brown (Phaeophyta) divisions. The colours of macro algae are due to different pigments that the algae use to convert the sunlight into chemical energy via photosynthesis. A total of 1010 species of macro algae has been reported from India. A large number of seaweed species known from the Indian seas are edible and serve various industrial purposes. They are most abundant along the Gujarat, Kerala and Tamilnadu coasts and around the Andaman and Lakshadweep Islands. The edible seaweeds from 70% of the standing stock of 100,000t, followed by algin (16%), Carrageenan (8%) and agar (6%) yielding seaweeds. The edible seaweeds are known to be rich in protein (20 to 25%) Carbohydrates (16 to 24%), lipids (6 to 11%) vitamins and amino acids.

2.2 Kingdom: Animalia

2.2.1. Phylum: Porifera (Sponges)

Sponges are multicellular organisms which have bodies have pores and channels allowing water to circulate through them, consisting of jelly-like mesohyl sandwiched between two thin layers of cells. About 519 species of sponges are known to occur in the Indian seas. About 34 species of coral boring sponges have been reported from the Gulf of Mannar and Island system of India (Thomas, 1996 a). Sponges are the major components of the benthic fauna and are distributed from the intertidal to the hadal depths and are a potential source of many new bioactive compounds. In India our knowledge of the identity, biology, availability, population structure and possibilities of commercial exploitation of sponges is meager and requires prioritization.

Ctenophora (Comb jellies): Ctenophora are live in marine waters and distinctive feature is the groups of cilia (comb) they use for swimming. They are the largest animals that swim by means of cilia. A total of 20 species of comb jellies has been reported from India.

2.2.2 Phylum: Cnidaria

Class: Scyphozoa (True jelly fish)

Scyphozoa is referred as the true jellyfish. Their stings may cause skin rashes, muscle cramps, or even death. A total of 30 species of Scyphozoans has been reported from India.

Class: Hydrozoa (Jelly fish)

Hydrozoans are small, predatory animals, some solitary and some colonial, and marine. The colonies are large, and in some cases the specialized individual animals cannot survive outside the colony. The Portuguese Man of War (*Physalia physalis*) and *Crambionella stulhamani* are important jelly fish species. About 116 species of hydrozoans belonging to 13 families have been reported from India.

Class: Anthozoa

Octocorallia (Soft Corals): Octocorallia belong to a subclass of Anthozoa. It includes the blue coral, soft corals, sea pens, and gorgonians (sea fans and sea whips) within three orders: Alcyonacea, Helioporacea, and Pennatulacea. Their life cycle includes a motile phase as plankton and later a sessile phase. About 300 species of soft corals have been reported from India. Gorgonids are popularly known as the sea fans or sea whips, the gorgonids are available in fishable magnitude in the Gulf of Mannar although distributed almost all along the Indian coasts including Andaman sea. These organisms support a minor export market providing raw material for the extraction of prostaglandins which are claimed to be wonder drugs. About 22 species belonging to 7 families and 15 genera were reported from India (Thomas, 1996 b).

The biomedical versatility of the gorgonids, popularly known as the sea fans, attracted great attention to this resource. Large quantities of sea fans have been exported from India to the USA, France, Germany and Netherlands. Many drugs (e.g. Prostaglandins) have been separated from the sea fans for treatment of various ailments. Owing to very attractive prices in the export markets, there has been indiscriminate exploitation of the sea fans from the Indian seas, particularly the Gulf of Mannar. Based on the color, the gorgonids are named in the trade as 'black', 'red', 'monkey tail' and 'flower'. The four species which have already shown symptoms of depletion include *Echinomuricea indicia*, *Heterogorgia flagellum*, *Echinogorgia complex* and *Gorgonella umbraculum* (Thomas and Ranimary George, 1987). Some of the less exploited grounds off Vizhinjam, Cape Comorin, Visakhapatnam, Okha, Dwaraka, Gulf of Kutch, Ratnagiri, Malwan, Andaman Islands, Rameswaram, Tondi and Point Calimer offer a limited scope of gorgonid exploitation through pruning, where the basal stalk is left undisturbed for regeneration, which takes place at the rate of about 2 cm per year.

Ceriantharia (Tube - dwelling anemones): Tube-dwelling anemones which are similar to sea anemones, but belong to the subclass of anthozoans. They are solitary, living buried in soft sediments. Tube anemones live and can withdraw into tubes, which are made of a fibrous material, which is made from secreted mucus and threads of nematocyst-like organelles, known as ptychocysts. The diversity included about 20 species in India.

Actiniaria (Sea anemones): The Actiniaria belongs to the class Anthozoa which includes sea anemones. They are water-dwelling, predatory animals. They have large polyps that allow

for digestion of larger prey and also lack a Medusa stage. They are related to corals, jellyfish, tube-dwelling anemones, and *Hydra*. Sea Anemone *Heteractis magnifica* Quoy and Gaimard, 1833 is associated with clown fish. Actinarian diversity included about 30 species in India.

Corallimorpharia (Coral anemones): Corallimorpharia is closely related to the true sea anemones (Actiniaria). The tentacles are usually short and arranged in rows radiating from the mouth. They resemble the stony corals, except for the absence of a stony skeleton. They occur in a wide range of marine habitats, and are associated with phase shifts in coral reefs that change from hard-coral dominated to soft-coral dominated. Diversity of Corallimorpharia includes about 10 species along the Indian coast.

Zoanthidea (Mat anemones): Zoanthids are commonly found in coral reefs, the deep sea and many other marine environments around the world. They may be in the form individual polyps, attached by a fleshy stolon or a mat that can be created from small pieces of sediment, sand and rock. A total of 8 species of Zoanthids has been reported from India.

Scleractinia (Reef building corals): Scleractinia are marine corals that form a hard skeleton. Most of the modern coral reefs are formed by scleractinians. About 200 species Scleractinia from the diversity of India (Pillai, 1996).

Antipatharia (Black corals): Antipatharia is treelike corals related to sea anemones and found in deeper depths. There are about 230 known species of black corals in 42 genera of this 10 species occur in India (Pillai, 1996). Though black coral's living tissue is brilliantly colored, it takes its name from the distinctive black or dark brown color of its skeleton.

2.2.3 Phylum: Platyhelminthes (Flat worms)

Platyhelminthes are bilaterally symmetrical, unsegmented, soft-bodied invertebrate worms. They don't have body cavity, and circulatory and respiratory systems, which made them to in a flattened shape. Nutrition and respiration are done by simple diffusion. About 100 species of flatworms have been reported from India. Research on the Platy helminthes of India is less as compared to the Annelids of India (Venkataraman and Wafer, 2005).

2.2.4 Phylum: Echiura (Spoon worms)

The Echiura are a small group of marine animals. They lack the segmented structure found in other Annelids of this group. Recent studies show they may be included in the phylum Annelida. About 43 species under 14 genera have been reported from India.

2.2.5 Phylum: Sipuncula (Peanut worms)

The Sipuncula are bilaterally symmetrical worms and contains about 144-320 species. Recent molecular work suggests that they may belong to phylum Annelida. They live in shallow waters, either in burrows or in discarded as molluscan shells. Some bore into solid rocks to make a shelter for themselves. About 35 species under 10 genera have been reported from India. They are concentrated mainly along the Andaman and Nicobar Islands, Lakshadweep Islands, Gulf of Mannar and Gulf of Kutch.

2.2.6 Phylum: Annelida

Class: Polychaeta (Clam worms)

The Polychaeta are generally marine, and belong to phylum Annelida. The body has a pair of fleshy protrusions called parapodia that bear many bristles, called chaetae, which are made of chitin. The annelid worm diversity includes about 300 species in India. Extensive research on the Polychaetes of India has been carried out of the Indian Ocean (Venkataraman and Wafer, 2005).

Class: Clitella

Oligochaeta (Earth worms): The Oligochaeta is different types of aquatic and terrestrial worms. Earthworms are semi aquatic or fully aquatic. There are several interstitial marine worms. About 10 species reported from India.

2.2.7 Phylum: Nemertea (Ribbon worms)

Nemertea belongs to the phylum of invertebrate and known as ribbon worms or proboscis worms. They have an unsegmented body, thin and elongated with no differentiated head. Ribbon worm diversity includes about 60 species in India.

2.2.8 Phylum: Arthropoda

Subphylum: Crustacea

India is endowed with rich diversity of crustaceans and several of them supporting commercial fisheries since ancient times. The recent changes in fishing patterns involving destructive innovations of fishing gears, excessive fishing pressure on some of the traditional stocks and the anthropogenic activities of man, causing damages to the natural habitat and diversity of crustaceans. The number of species entering into the systematic list is on the increase as a consequence of the extension of fishing activities to deeper waters and capture of non conventional species. The marine king crab of the species *Tachypleus gigas* and *Carcinoscorpius rotundicauda* occurs in the detect regions of Ganges and Mahanadi along the northeast coast. They are considered as living fossil and hence care should be taken to preserve them in the nature. Recently because of biotic interference there has been a decline in the numbers of these animals in Orissa. The chemical reagent *list* is produced from the blood of this crab. This medicine has got a wide usage in the treatment of several diseases.

Class: Maxillopoda

Cirripedia (Barnacles): They have a calcareous shell composed of several pieces. They are known as curl footed because of their curved legs. A total of 36 species of cirripedia has been reported from India.

Class: Malacostraca

Order: Amphipoda (Land hoppers)

Amphipoda is having no carapace and generally with laterally compressed bodies. Amphipods range in size from 1 to 340 millimeters and are mostly detritivores or scavengers. They live in marine aquatic environments. A total of 132 species of Amphipods belonging to 54 genera have been reported from India.

Order: Isopoda (Pill bugs, sow bugs)

The Isopoda are small crustaceans with seven pairs of legs in the size of above 300 micrometers. They have dorso-ventrally, flattened body, without carapace. There are about 33 species belonging to 13 genera have been reported from India.

Order: Stomatopoda (Mantis shrimp)

Stomatopods are marine crustaceans and they occur in a variety of different colours, from shades of browns to bright neon colours. These aggressive and typically solitary sea creatures spend most of their time hiding in rock formations or burrowing indicate passageways in the sea bed. Unlike most crustaceans, stomatopods hunt, chase, and kill their prey. Most species live in tropical and subtropical seas although some live in temperate seas. The stomatopod diversity includes about 30 species along the Indian coast.

Order: Decapoda

Dendrobranchiata (Shrimp, prawns): Dendrobranchiata are decapod crustaceans, known as shrimp or prawns. There are 540 extant species in seven families. They differ from related animals, such as Caridea and Stenopodidea, from the branching form of the gills and by the fact that they do not brood their eggs, but release them directly into the water. They are widely fished and farmed for human consumption. About 10 species have contributed to the diversity in India.

Caridea (Caridean shrimp): The caridean shrimp is an infraorder of shrimp within the order Decapoda. They are found widely around the world in both fresh and salt water. Carideans are found in every kind of aquatic habitat, with the majority of species being marine. The most significant commercial species among the carideans is *Pandalus borealis*. About 150 specimens included in the caridean shrimp diversity of India.

Palinura (Lobsters): Lobsters have a cylindrical, sub ovoid or dorso-ventrally compressed carapace and flattened abdomen. The group includes the spiny lobsters and slipper lobsters. The abdomen is flattened.

Thalassinidea (Ghost shrimps, mud shrimps): Thalassinidea include crustaceans, which live in burrows in muddy bottoms of the sea. They are characterized by a relatively soft cuticle (shell) in most common forms. Thalassinids typically live in deep and sometimes complex burrows. Shallow water local species typically remain deep in the burrow and suspension feed (filtering plankton and organic particles from the water) by beating their pleopods to create a current. About 20 species of Thalassinides have been reported from the Indian Ocean.

Anomura (Hermit crabs, sand crabs): Anomura is a group of decapod crustaceans, including hermit crabs and others. All true crabs are in the sister group to the Anomura. A total of 20 species Anomuran crabs have been reported from India.

Brachyura (Crabs): Crabs are decapod crustaceans with a typically very short tail, usually entirely hidden under the thorax. A total of 250 species of crabs has been reported from Indian coast.

2.2.9 Phylum: Mollusca

Molluscs in general had a tremendous impact on Indian tradition and economy and were popular among the common man as ornaments, currency, as a part of spiritual activities even at the inception of human culture and civilization.

Class: Scaphopoda (Tusk shells)

The Scaphopoda are commonly known as the tusk shells. They have a tubular shell is open at both ends as compared as other molluscs open at one end. Tusk shells live in seafloor sediment where they feed on detritus, foraminiferans and microscopic animals. Scaphopod diversity includes about 10 species.

Class: Polyplacophora (Sea cradles)

Polyplacophorans include about 600 extant species are entirely marine, and inhabit hard bottoms and rocky coasts. Chitons are small to large marine molluscs. These molluscs are also sometimes commonly known as sea cradles. A total of 40 species of polyplacophora has been reported from India (Appukuttan, 1996).

Class: Gastropoda

Prosobranchia (Sea snails): Prosobranchia includes sea snails, land snails and freshwater snails. *Prosobranch* means *gills in front* (of the heart). In contrast *Opisthobranch* means *gills behind* (and to the right of the heart). Prosobranchs have their gills, mantle cavity and anus situated in front of their heart. Most prosobranchs have separate sexes. The diversity of prosobranchian species was at the tune of 2550 species.

Opisthobranchia (Gastropods): Opisthobranchs are a large and diverse group of specialized complex marine gastropods previously united under Opisthobranchia within the Heterobranchia, but no longer considered to represent a monophyletic grouping. About 400 species of gastropods have been reported from India.

Pulmonata (Snails, slugs): The Pulmonata, or pulmonates, are an informal group of snails and slugs characterized by the ability to breathe air, by virtue of having a pallial lung instead of a gill, or gills. The group includes many land and freshwater families, and several marine families. A total of 20 species of pulmonates was recorded from India.

Class: Bivalvia (Clams, oysters): Bivalvia are mollusks with laterally compressed bodies in a shell in two hinged parts. They include clams, oysters, mussels, scallops, and numerous other families of shells. They are filter feeders and most often bury themselves in sediment on the seabed and lie on the sea floor or attach themselves to rocks or other hard surfaces. The bivalve diversity includes about 667 species in India.

Class: Cephalopoda (Squids, cuttlefishes, octopuses): Cephalopods are marine animals are characterized by bilateral symmetrical body with a head, and a set of tentacles. They have the ability to squirt ink. About 20 species of cephalopods were found in India. Cephalopod ink contains chemical substances of vast nutraceutical value.

2.2.10 Phylum: Echinodermata**Class: Echinoidea (Sea urchin)**

Sea urchins move slowly, feeding mostly on algae. Sea otters, wolf eels, triggerfish, and other predators feed on them. A total of 60 species of sea urchins was showed occurrence in the Indian seas.

Class: Holothuroidea (Sea Cucumbers)

Sea cucumbers are marine animals are found on the sea floor. Total number of holothurians species is 1,250 in the world and maximum number being in the Asia Pacific region. Many of these are utilized for human consumption and some species are used in aquaculture systems. Sea cucumbers serve a useful purpose in the marine ecosystem as they help recycle nutrients, breaking down detritus and other organic matter

after which bacteria can continue the degradation process. About 150 species of sea cucumber have been reported from India. About 12 species of sea cucumber are economically important and have commercial value (James, 1996). Increasing demand has led to massive exploitation of sea cucumbers often resulting in the removal of undersized animals.

Class: Asterozoa (Star fish)

The starfish is among the most familiar and diversity of marine invertebrates. They have a central disc and five arms, and some species have more than five arms. They ochre sea star (*Pisaster ochraceus*) and the reef sea star (*Stichaster australis*) are widely known as examples of the keystone species concept in ecology. A total of 180 species of starfishes belonging to 81 genera have been reported from India.

Class: Ophiurozoa (Brittle Stars)

They have a disk and generally have five long slender, whip-like arms which may reach up to 60 centimeters in length on the largest specimens. A total of 150 species of brittle stars belonging to 79 genera have been reported from India.

Class: Crinozoa (Sea lilies)

They live both in shallow water and in depths up to 6,000 meters. Sea lilies in their adult form are attached to the sea bottom by a stalk. They have a mouth on the top surface that is surrounded by feeding arms. Crinoids usually have a stem used to attach them to a substrate, but many live attached only as juveniles and become free-swimming as adults. A total of 95 species belonging to 43 genera have been reported from India.

2.2.11 Phylum: Phoronida (Horseshoe worms)

They live in most of the oceans and seas including the Arctic Ocean but excluding the Antarctic Ocean, and between the intertidal zone and about 400 meters down. About 5 species of phoronids were reported from India.

2.2.12 Phylum: Brachiopoda (Lamp shells)

They have hard shells on the upper and lower surfaces, unlike the left and right arrangement in bivalve molluscs. There are two types are recognized, articulate and inarticulate. Articulate brachiopods have toothed hinges and simple opening and closing muscles, while inarticulate brachiopods have untoothed hinges and a more complex system of muscles used to keep the two halves aligned. About 5 species of Brachiopods were found in India.

2.2.13 Phylum: Bryozoa (Moss animals)

They are known as Polyzoa, Ectoprocta or moss animals are aquatic invertebrate animals. Size range from 0.5 millimeters long, and are filter feeders. Most marine species live in tropical waters, but a few occur in oceanic trenches, and others are found in polar waters and few prefer brackish water. Over 4,000 living species are known. One genus is solitary and the rest colonial. There is a rich biodiversity in India with about 500 species are reported so far. Several collections and descriptions in the past enriched the knowledge about the Bryozoans occurring along the Indian coast (Venkataraman and Wafer, 2005).

2.2.14 Phylum: Hemichordata (Acorn worms)

Acorn worms are solitary live in burrows and are deposit feeders, and species are filter feeders. About 12 species of hemichordates have been reported from India as compared to global species of 102.

2.2.15 Phylum: Chaetognatha (Arrow worms)

Arrow worms are predatory marine worms that form a major component of plankton worldwide. About 20% of species are benthic, and can attach to algae and rocks. They are marine and occur in surface tropical waters and shallow tide pools to the deep sea and Polar Regions. They range in size from 2 to 120 millimeters. A total of 30 species have been reported from India. They are abundant all along the Indian coast. Chaetognaths of Indian seas have been studied extensively along the Malabar Coast, Vishakhapatnam Coast, Andhra coast and Indian Ocean during the sixties (Venkataraman and Wafer, 2005).

2.2.16 Phylum: Chordata

Class: Thaliacea (Pelagic tunicates)

Thaliaceans are free-floating for their entire lifespan. They include both solitary and colonial species. Thaliaceans have 30% carbon by mass. Therefore their dense bodies sink to the bottom of the oceans when they die and this may be a major part of the worldwide carbon cycle. A total of 40 species was reported from India.

Class: Ascidiacea (Sea squirts)

Ascidians are found all over the world, usually in shallow water with salinities over 2.5‰ the members of the Thaliacea and Larvacea swim freely like plankton, sea squirts are sessile animals. A total of 50 species belonging 21 genera have been reported from India against 2000 species of Asidian in the world.

Class: Pisces

Fin fishes: Recent analysis indicates that 18 resource groups fall under the abundant category, five fall under less abundant category and one each fall under declining, depleted and collapsed category. The 18 stocks resource groups under the abundant category or less abundant category indicating good condition of their stock. The less abundant category includes elasmobranchs, threadfins, ribbon fishes, mullets and flat fishes. Big-jawed jumper under the declining category flying fishes under depleted and unicorn cod is in the collapsed category. While certain stocks such as those of Mackerel, Lesser Sardines, White bait, Seer fish, Coastal and oceanic tunas, Croakers, Pig face bream, Groupers, Snappers, Catfish, Lizard fish, Silver bells and Goat fishes are exploited all along the Indian coast. Bombay duck is caught mainly along the Gujarat and Maharashtra coast and to a lesser extent along certain pockets of Andhra, Orissa and West Bengal coasts. Hilsa is harvested mainly along the West Bengal coast and Gujarat coast.

Elasmobranchs: The elasmobranchs consists of sharks, sawfishes, rays, skates and guitar fishes. They are fished using different types of gears and in recent years have assumed great significance in the export market. They are exploited by a variety of fishing gears like gill

nets, long lines and trawls along the Indian coast by both traditional and mechanized sector (Raje *et al.*, 2002). Though there is no directed fishing for elasmobranchs in certain places of Tamilnadu, large meshed bottom set gill nets called as 'thirukkuvalai' are operated for fishing the rays. They are all predatory feeding on a wide range of zooplankton to benthic invertebrates, bony fishes, other sharks, turtles, seabirds and marine mammals (Joshi, 2012).

In India, we have listed out about 110 species of elasmobranch which includes 66 species of sharks and 44 species of batoides. The recent description of new records and new species may lead to this figure to about 150-170 species from Indian coast alone. The whale shark is huge, sluggish, pelagic filter-feeder, often seen swimming on the surface. Viviparous and gravid female have 300 young ones of several stages of development. The protected elasmobranchs as per the Wildlife (Protection) Act, 1972, Schedule I are *Rhincodon typus* (Whale shark), *Anoxypristis cuspidate* (Pointed saw fish), *Pristis microdon* (Largetooth sawfish), *Pristis zijsron* (Longcomb sawfish), *Carcharhinus hemiodon* (Pondicherry shark), *Glyphis gangeticus* (Ganges shark), *Glyphis glyphis* (Spear tooth shark), *Himantura fluviatilis* (Gangetic sting ray), *Rhyncobatus djiddensis* (Giant guitarfish) and *Urogymnus asperimus* (Thorny ray).

Ornamental fish: The Gulf of Mannar, Palk bay, Gulf of Kutch, South West coast and the Lakshadweep and Andaman group of Islands are known to be rich in Ornamental fishery. The Wrasses, damsel fish, Surgeon, Butterfly fish, Moorish idol, Squirrel fish, Trigger fish, Rabbit fish, Parrot fish, Angels, Goat fish and Puffer fish are the major aquarium fishes represented by about 180 species (Murty *et al.*, 1989; Murty, 2002). As the majority of these fishes is associated with coral reefs and those in great demand are not very abundant, their exploitation may disturb the habitats and result in depletion of stock, if a suitable mechanism for sustainable exploitation using for example sample traps and monitoring the exploitation and export is not developed. The sea horses and pipe fishes are known to live sea grass beds, mangroves and reefs in shallower coastal waters of the temperate and tropical regions, about 300 species of about 30 genera are known (Vincy, 1995). CITES have listed all the sea horse in the Appendix I stop the trade of these organisms. Indian wild Life Act 2002 also protects the sea horse by putting them on Schedule list I. Dried sea horse has got a high demand in Singapore and China for making soup and for medicinal purposes.

Class: Reptilia

Marine reptiles: Marine reptiles are air-breathing, ectothermic, poikilothermic vertebrates. Their skin is covered with dry scales and lays their egg on land. Out of the 700 living species only few species of snakes, turtles, and crocodiles are seen in the ocean.

Order: Chelonia

Sea Turtles: Five species of sea turtles were reported In India which include, Olive Ridley (*Lepidochelys olivacea*) Green Turtle (*Chelonia mydas*), Leather back (*Dermochelys olivacea*), Hawksbill (*Eretmochelys imbricate*) and Loggerhead (*Caretta Caretta*). Sea turtles have an armor-like shell, as carapace and that is fused to the backbone. Unlike their terrestrial counterparts sea turtles cannot retract their heads into the shell. Their legs especially forelimbs are modified into flippers for swimming. Green turtles (*Chelone mydas*) are found in coastal water and feed mainly as sea grasses and seaweeds. The hawksbill turtle (*Erectmochelys imbricata*) feed on encrusting animals like sponges, sea quirts, barnacles and sea weeds. The largest sea turtle the leather back (*Dermochelys coriacea*) have a series of

shells and an oceanic species. They have scissor-like jaws for capturing and they feed on jellyfish. Other species feed on soft, bottom invertebrates like sponges, soft corals, jellyfishes and crabs. Prey-predator relationship in the ecosystem is one of the important factors in limiting as well as the proliferation of organisms due to the decline of the one of the components in the trophic relations. A recent spurt of the Jellyfish biomass in different parts of the coastal ecosystem can be attributed to the decline of turtle populations in the ecosystems. Except green turtles all other turtles feed heavily on Jelly fishes and prevent the proliferation of the population. All species of marine turtles are in the endangered category, and are therefore, protected under the Indian Wildlife Act, 1972. In view of their endangered status and total ban on the trade of sea turtles and their products under CITES, proper identification of the species and information on their biology are essential for monitoring the resource.

Class: Reptilia

Order: Squamata

Sea Snakes: Sea snakes occur in the tropical and sub-tropical waters of the Indian Ocean from the east coast of Africa to Australia. They occur in shallow coastal waters, estuary, lakes and fresh water in the rivers away from the sea. They feed on fish, fish eggs, crustacean and tuna. The genus *Laticauda* is oviparous and all other sea snakes are viviparous. The sea snake bite is dangerous and it is neurotoxic like terrestrial snakes like karate and cobra. Sea snakes are mainly exploited for their skin, poison and meat. Most of the sea snake fisheries in Indian Ocean have not been reported and no data available on it. There are about 80 species sea snakes belonging to three families inhabiting the world oceans and estuaries. In Indian waters, about 22 species of marine snakes belonging to three families have been documented. Twenty species are represented in the family Elapidae, of which 18 belong to sub-family Hydrophiinae (true sea snakes) and two belong to sub-family Laticaudinae (sea kraits); one species belong to the sub-family Homalopsinae under family Colubridae, and a single species are represented in the family Acrochordidae.

Order: Crocodilia

Salt water crocodiles: Salt water crocodile, *Crocodylus porosus* (Schneider, 1801) is the largest reptile in the present world with about six meter lengths and up to one metric ton weight. They can live in salt water but usually occurs in mangrove swamps, estuaries, deltas, lagoons and lower stretches of rivers. The historical geographical range of these species is from Cochin to Sunder bans and up to the Andaman Islands. They can travel 1000 km by sea. Due to hunting and loss of habitat these animals do not exist in Kerala and Tamilnadu. They spent the tropical wet season in freshwater swamps and rivers, moving downstream to estuaries in dry season and sometimes to sea. Juveniles feed on smaller insects, amphibians, crustaceans, reptiles and fish. The larger animals feed on monkeys, mammals, birds, domestic livestock, pets, buffalo, sharks and humans. The species is endangered due to hunting, loss of habitat and breeding sites. Marsh crocodile or Indian swamp crocodile is *Crocodylus palustris* (Lesson, 1831) found in rivers, swamps, lakes and saltwater lagoon. Indian Gharial is *Garialis gangeticus* (Gmelin, 1789) are found mainly in the river Ganga, Brahma Putra and Mahanadi. The crocodile Bank located in Chennai to conserve the endangered reptiles like crocodile and alligators.

Class: Aves

Sea birds: Sea birds are long lived, with very low natural mortality. They are also characterized by being late to mature and slow to reproduce and some cases, they will start breeding at the age of ten years old. Most of them lay a single egg each year. These biological traits and human induced adult mortality potentially damaging population decreases and collapse of the population. Also most of the tropical sea bird species fell in association with tuna stocks which derive their prey to the surface thereby bringing within the reach of the sea birds. The depletion of the tuna stocks could therefore have impacts on their dependent species like sea birds. The cascade effects of reduce tuna or shark on the ecosystem is not known.

Common birds are Grey heron (*Ardea cinerea*), Pond heron (*Ardeola grayii*), Large egret (*Egretta alba*), Little egret (*E. garzetta*), Painted stork (*Ibis leucocephalus*), Spoon bill (*Platalea leucocordia*), Flamingo (*Phoenicopterus roseus*), Parian kite (*Milvus nigrans*), Golden plover (*Pluvialis dominica*), Black headed Gull (*Larus ridibundus*), Gull billed Tern (*Geolchelidon nilotica*), Caspian tern (*Hydroprogne caspia*), Little tern (*Sterna abilfrons*) and Sandwich tern and (*Sterna sandvicensis*). Three species of Albatross are endanger (IUCN) two species near threatened and one is critically endangered (IUCN). Sea birds occur along the Gulf of Kutch, Gulf of Mannar, Chilka Lake, Coringa Wild life Sanctuary and the Sundarbans, Islands of Laccadive such as Pitti and Batapari are the colonies of sea birds. Sundarbans are important staging and wintering area of gulls and terns.

Class: Mammalia

Marine Mammals: All marine mammals belonging to the whales, dolphins, porpoises and dugong are rare and endangered, and are listed under CITES. They migrate to the tropical seas for feeding and breeding and often get entrapped in the tide and washed ashore or entangled in the fishing gears. Dugongs get entangled in fishing gears while feeding on the sea grass beds along the Gulf of Mannar. Often there has been clandestine fishing for the dugongs along the Gulf of Mannar. The meat is highly relished by the local people and hence the dugongs are often exploited. This has led to a drastic decline in their population. The destruction of seagrass beds due to trawling has further aggravated the situation. The possible occurrence areas of digging are the Gulf of Mannar and Palk Bay, Gulf of Kutch, Andaman Islands. As the dugong inhabits the narrow Palk Strait and the contiguous Gulf of Mannar between India and Sri Lanka, conservation requires international understanding and cooperation (Vivekanadan and Jeyabasker, 2013). Marine mammals come under the class Mammalia; globally 130 species were so far recorded. They included in three orders namely Cetacea (whales, dolphins, and porpoises), Sirenia (manatees and dugong), Carnivora (sea otters, polar bears and pinnipeds like seals and walrus). In India, 31 species of marine mammals (30 species of Cetacea and one species of Sirenia) are documented accounting to one fourths of the world's marine mammalian fauna and almost 8% of the total Indian mammalian fauna.

Conclusion

The exploited marine fisheries resources from the coastal area have been reached maximum from the present fishing grounds up to 200 m depth. The coastal fisheries faces several threats such as indiscriminate fishing, habitat degradation, pollution, social conflicts, the introduction of highly sophisticated fishing gadgets, need management

measures and conservation of marine biodiversity to maintain sustainable use of marine biodiversity. Human activities are the major causes for the loss of biodiversity and degradation of marine and coastal habitats, which needs immediate attention and comprehensive action plan to conserve the biodiversity for living harmoniously with nature. Some of the measures such as control of excess fleet size, control of some of the gears like purse seines, ring seines, disco-nets, regulation of mesh size, avoid habitat degradation of nursery areas of the some of the species, reduce the discards of the low value fish, protection of spawners, implementation of reference points and notification of marine reserves for protection and conservation of marine and coastal biodiversity.

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Advances in Harvest Strategies: Experiences of CIFT in Responsible Fisheries

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Introduction

Different types and methods of fishing gears ranging from small-scale artisanal to large scale industrial fishing systems are used for harvesting the fishery resources. Several advanced technologies in harvesting of fish have taken place over the last few decades. The most significant developments in the area of fish harvesting technologies are (i) Advances in fishing craft technology along with mechanization of propulsion, gear and catch handling (ii) introduction of synthetic gear materials in the fishing industry (iii) Advances in acoustic fish detection and satellite-based remote sensing techniques (iv) advances in electronic navigation and communication equipment (v) awareness of the need for responsible fishing to ensure sustainability of the resources, protection of the biodiversity, environmental safety and energy efficiency.

Significant developments have also taken place in the fishing gear materials, design and fabrication and operation of these fishing gears in the last few decades. Advances in both fishing craft technology and fishing gear technologies have increased the efficiency of fishing. These developments has increased the fish production multifold but over the years, has put tremendous pressure on the resources. This has led to responsible fishing techniques for a long term sustainability of fishery resources. The Central Institute of Fisheries Technology, which is the foremost and premiere R&D organization in south east Asia deals with the entire spectrum of harvest and post harvest technology of fish focuses on the responsible fishery development both in the harvest and post harvest sectors.

CIFTs role in advances in responsible harvest strategies

Trawls:

Since its introduction in 1960s trawling has become an established fishing method in India and is being practiced throughout the coastal states of the country. The trawl net has undergone many modifications in its design, fabrication and operation depending to the type of fishes caught, local conditions, size and the engine power of the trawler employed for fishing.

With commencement of organized trawling in the country, designs of 11 four seam and 7 two seam trawls were recommended by CIFT. Many innovations were introduced to increase the catching efficiency of trawls such as tickler chains for shrimp trawls, To meet the ever increasing export demand of shrimps, the fleet size and effort considerably increased and as a result of intensive fishing a down ward trend in the CPUE was observed in the late seventies. In order to increase the catches and shift the emphasis from shrimps, new trawl designs were developed to catch off bottom quality fishes along with shrimps. New designs of fish trawls were developed for exploiting the fish resources in the shallow waters. Revolutionary changes took place in fishing gear materials and the trawl nets changed from natural materials like cotton to synthetic materials like nylon and polyethylene (PE) and presently all the trawls are made up of PE. Choosing the right size of trawl based on the power of the vessel, relationship between mesh size and twine size for trawls is extremely important for efficient performance of the trawl gear.

Long wing trawls were designed and developed to increase the horizontal opening and the total swept area, Sweep lines were attached to increase the herding effect and there by increasing the catching efficiency of trawls. The mesh size particularly in the fore of the trawl net has undergone significant changes in the course of time along with increase in dimensions of the net. Over the years, CIFT has designed several trawls such as two-seam trawl, four-seam trawl, six-seam trawl, long wing trawl, bulged belly trawl, high opening trawl and semi pelagic trawl and introduced energy saving concepts in trawl design such as large mesh trawl and rope trawl for bottom trawling. The large mesh trawls were enthusiastically adopted by the fishermen and there have been significant increase in the mesh sizes in the fore parts of the trawl owing to its energy saving benefits and catch efficiency for fin fishes.

Studies on selectivity on trawls were carried out and optimum mesh sizes were worked out for shrimp and fish trawls. Cod end selectivity studies have been worked for several commercial species. The Institute now focuses in designing trawl gear with improved selectivity and energy efficiency, reduced negative environmental impact to protect the biodiversity and environment and to ensure long term sustainability of the fishery resources.

The size of the trawl net has increased considerably along with the size of trawlers. After the introduction of synthetic fibres in the fishing industry in the early sixties all the

commercial trawl nets are fabricated exclusively using high density polyethylene (HDPE) twines of different twine sizes. The earlier practice of fabrication of trawl net by hand braiding have completely ceased as ready-made netting have become readily available in the market. Trawl designs of two seam and four seams are prevalent in the commercial sector. There are resource specific trawl designs for targeting the major resources, like shrimps, cuttlefish, squids, and ribbonfish. Trawls with very large mesh upto 6000 mm are now being used in the fore parts of the net targeting fish with high towing speeds. With the increasing number of trawlers in the country, there is great demand for good designs of ready-made trawl nets. Many net makers have established themselves over the years and have gained experience in the art of designing and fabricating trawl nets by keeping the wastage of netting materials to the minimum.

A large number of non-targeted species and juveniles are landed during trawling, in addition to its impact on benthic communities Trawl System (CIFT SPTS-I) has been developed as an alternative to shrimp trawling in the small-scale mechanized trawlers operating in the tropical waters (CIFT, 2007). The system consists of an 18 m four panel semi-pelagic trawl with double bridles, front weights and vertically cambered high aspect ratio otter boards of 85 kg each. It is capable of attaining catch rates beyond 200 kg.h⁻¹ in moderately productive grounds and selectively harvest fast swimming demersal and semi-pelagic finfishes and cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India.

Trawl bycatch in the tropical waters has a significant percentage of juveniles. Various types of bycatch reduction technologies have been developed in the fishing industry around the world. The Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) is a Smart Gear (WWF) award winning design developed by Central Institute of Fisheries Technology (CIFT) which brings down the bycatch of juveniles and small sized non-targeted species in commercial shrimp trawl and at the same time enables fishermen to harvest and retain large commercially valuable finfishes and shrimp species (Boopendranath et al., 2008). In addition, the fishermen would benefit economically from higher catch values due to improved catch quality, shorter sorting time, longer tow duration, higher catch and lower fuel costs. JFE-SSD operations off Cochin (India) have realised bycatch reduction up to 43% with a shrimp retention of 96-97%.

Various other BRDs like the bigeye BRD, fisheye BRD are provided on the upper side of the codend or belly of the trawl net and they function based on the differential behaviour of fishes and shrimps. Fishes that have entered the codend tend to swim back and escape through the openings, at the top in the front section of the codend. Square mesh has the advantage that the mesh opening is not distorted while under operation, unlike diamond meshes. Bycatch exclusion rates of 35-51% with a shrimp loss of 0.8-2% have been reported during trawl operations in Indian waters, using 200x300 mm semi-circular fisheye BRD. Seive net is another BRD are cone shaped nets inserted into standard trawls which direct unwanted bycatch to an escape hole cut into the body of the trawl leading to a second codend. The large mesh funnel inside the net guides the fish to a second codend with large diamond mesh netting, while shrimps pass through large meshes and accumulate in the main codend. Bycatch exclusion rates of 14.7 % with shrimp loss of 5.5% have been reported in sieve net installed trawl operations. Several designs of rigid grid sorting devices have

been developed for separation of shrimp from non-shrimp resources, Bycatch exclusion rates of about 58%, with a shrimp loss of 8% have been reported during trawl operations in Indian waters, using rigid sorting devices.

Turtle Excluder Devices:

Many trawl fisheries throughout the world are now required to use TEDs for their shrimp trawl fisheries. TEDs are a convenient and effective measure for protecting sea turtles from trawling-related mortality and also for reducing bycatch in shrimp landings. CIFT-TED is an efficient turtle excluder device developed at CIFT with focus on reducing catch losses, Catch losses during the operations due to installation of CIFT-TED were in the range of 0.52-0.97% for shrimp and 2.44-3.27% for non-shrimp catch components

Regulation of mesh size in codend of trawls

Mesh size regulation is an important step towards reducing the growth overfishing, rampant in Indian fisheries. The institute has conducted selectivity studies for trawls. Codend mesh regulation has been incorporated in the Marine Fishing Regulations Acts of several maritime states of India, it has never been enforced effectively in trawl fisheries in India. The lumen of conventional diamond mesh used in trawl codends tends to close under tension, during the tow and hauling operations affecting the exclusion of bycatch and juveniles Diamond mesh netting, when turned through 90 degrees (T-90), has been reported to have better selective properties, as the mesh lumen does not, close completely under tension as in diamond mesh netting stressed in 'normal direction.

Purse seine:

Purse seine was first started in India by the erstwhile Indo Norwegian Project (INP) in 1950s. However, it has been commercially operated in India since 1976. Purse seining is one of the most efficient and advanced commercial fishing methods. It is aimed mainly at catching dense, mobile schools of pelagic fish and includes all the elements of searching, hunting and capture. A purse seine winch is used for retrieval of the ring rope that passes through the purse rings attached at the bottom of the net which closed the net in the bottom. Over the years, the size of purse seine net has increased considerably and it has become labour intensive and time consuming to haul up such huge net. During 1982-83 the Central Institute of Fisheries Technology (CIFT), Cochin developed and introduced a mini purse seine, popularly known as ring seine. The institute also introduced large mesh purse seines with 45 mm for large mackerels, tuna, seer and other quality fishes. With the introduction of large mesh purse seines along with modification of the vessels and use of equipment like sonar and power block, the fishers can venture into deep sea purse seining targeting the underexploited tuna and other large pelagic fishery resources in the Indian EEZ.

In case of purse seine there is always a possibility of having bycatch. Special escape panels known as Medina panels, which are section of fine mesh that prevent dolphins from becoming entangled in the net and back down maneuver have been deployed to prevent capture of dolphins in purse seines.

In purse seiners, hauling devices like the Power block is being used by fishermen of Goa and Kerala. This saves time in hauling of the purse seine net and fishermen can operate more sets.

Gill nets:

Gill net is a passive fishing gear and is operated by artisanal as well as mechanized fishing boats. It can also be operated without a fishing craft and can be seen in the inland and marine sectors. Gill nets too switched over to synthetic materials from natural fibres. Introduction of monofilament yarn has revolutionized gill net fishing. The institute recommended standard mesh sizes for gill net for commercially important species. It also recommended yellow coloured gill nets for hilsa and pomfrets for increased catching efficiency. As gill net material is non-biodegradable lost gill nets continue to gill and entangle fish and other marine organisms leading to unwanted mortality (ghost fishing). Use of biodegradable natural fibre twines or time release elements to connect the netting to floats can prevent ghost fishing.

CIFT role is significant in changing over of the material for gill nets from cotton and hemp to synthetics, polyamide multifilament and initially later to PA monofilament and to HDPE. Nylon multifilament was found to be 7.5 times more efficient over cotton and Nylon monofilament was found to be 2.5 times more efficient over nylon multifilament. Other materials like PP twine and PE (tape twisted twine, PE yarn, and PE twisted monofilament) were also found to be suitable substitutes for nylon.

The Institute introduced large mesh drift gill nets for large pelagics in Lakshadweep islands. Optimum meshes for gill nets for important species have been recommended by CIFT.

By catch in gill nets may include mammals, sea turtles, and sea birds in addition to non target species. Mesh size optimization and judicious deployment of gill nets in terms of fishing grounds, fishing depth and season to minimize interaction of non target species is an important measure to reduce by catch. acoustic pingers can be used in gill nets so that marine mammals that have echolocation abilities can detect it.

Hooks and lines:

Fishing hooks and lines are among the simplest of fishing gear. Handline, trolled line, set line, drift line, pole and line, squid jigging and long lines fall under hook and line fishing. . Fishing with troll lines, baited with artificial lures, popularly known as trolling is an effective and important gear for the capture of pelagic fishes like seer, tuna, skipjack, bonito, etc. Considerable research has been carried out by the Institute on troll lines. The Institute was involved in the conversion to mechanized trawlers to long liners in the country. Operation of long lines is a labour intensive and time consuming fishing method. automated systems for shooting and hauling of the lines are available which will help the fisherman to operate the lines efficiently. Recently the institute also carried out modification of Pablo boats for operation of tuna long lines at various islands in Lakshadweep.

There are also technologies to reduce by catch in hook and line fishing. Optimized hook design and size and selection of bait type and bait size appropriate for the target species and size class, proper choice of fishing ground, depth and time of fishing are approaches for reducing by catch in hook and line fisheries. Sea turtle mortality in long line

operations have been reduced by using circle hooks in place of conventional J-hooks. Setting of tuna longlines at depths greater than 100 m using weighted lines has been reported to reduce bycatch of recreationally important fish species and protected species such as seabirds and sea turtles. Magnetic field generated using rare earth magnets in the proximity of hook has been reported to deter sharks and has been proposed for reducing the bycatch of sharks in pelagic long lines.

Traps:

Trap is a traditional fishing gear into which an organism is lured inside and from which the fish gets trapped and the escape is made difficult. Traps are used for catching fishes, crabs, lobsters or even molluscs. Traps have many advantages like it requires low energy as compared to active fishing method. The organisms caught in the trap can be retrieved alive in an undamaged condition and the trap can be operated continuously day and night. Trap fishing is economical as the capital investment is relatively low and traps show a high degree of selectivity. Traps are generally species specific, and the fishes are caught live, the by catch can be released back in live condition. The CIFT improved lobster trap made of GI rods and wire mesh coated with plastic to avoid corrosion is very successful and popular and is used by the fishermen of Kanyakumari district (muttam, kadiyapatnam and Inayam). A provision of escape windows can be made for escapement of juveniles and non target species. Ghost fishing by traps is a disadvantage in case of trap fishing. Institute developed a modern efficient lobster trap. An escape gap of 150x30 mm is provided at one side as a conservation measure. The trap is plastic coated in full for preventing corrosion in seawater. CIFT also developed collapsible crab traps for the traditional fishermen.

Bycatch and minimizing ecological impacts of fishing operations has been of concern by the scientists, fishery managers and fishermen. Bycatch can be reduced by reduction in the overall fishing effort, implementation of regulatory fishing bans, installation of BRDs and TEDs. It also can be reduced by operational changes, by reduction in speed and duration of trawling, avoiding areas of high bycatch. Responsible harvesting techniques should be encouraged and implemented under a co-management regime with stakeholder participation for successful implementation.

Impact and Adaptation Options For Indian Marine Fisheries To Climate Change

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Introduction

With global warming, the waters of oceans are also warming up though there are considerable variations in different geographical regions and at different times. Warming has been more intense in surface waters, and there are evidences for deep water warming too. The world's oceans are also affected by changes in precipitation, wind and currents, which are the result of geographical differences in temperature and humidity of the atmosphere. Thus, important oceanic weather systems such as the *El Niño* Southern Oscillation (ENSO) and Indian Ocean monsoon will be affected by global warming. Other direct effects of warming on aquatic systems include changes in precipitation, evaporation, river flows, groundwater, lakes and sea levels (see Prasannakumar et al., 2009). These changes have altered the energy balance in the atmosphere, resulting in a warming effect.

Marine ecosystems are not in a steady state, but are affected by the environment, which varies on many spatial and temporal scales. Changes in temperature are related to alterations in oceanic circulation patterns that are affected by changes in the direction and speed of the winds that drive ocean currents and mix surface waters with deeper nutrient rich waters (Kennedy et al., 2002). These processes in turn affect the distribution and abundance of plankton, which are food for small fish.

Besides, the rising acidity levels in the seas as a result of the climate change have negative effect on coral reefs and calcium-bearing organisms. Global warming and the consequent changes in climatic patterns will have strong impact on fisheries with far-reaching consequences for food and livelihood security of a sizeable section of the population. The Food and Agriculture Organization (FAO) has pointed out that the responses of capture fisheries to climate change are fundamentally different from other food production systems (FAO, 2008). Unlike most terrestrial animals that constitute the livestock sector, aquatic animal species used for human consumption are poikilothermic, meaning their body temperatures vary according to ambient temperatures. Any change in habitat temperatures significantly influence their metabolism, growth rate, productivity, seasonal reproduction, and susceptibility to diseases and toxins, the report points out. This

is likely to result in significant changes in fisheries' production in world oceans. The magnitude of impact would vary in different regions. For communities that heavily rely on fisheries, any decrease in the availability of fish will pose serious problems.

In the last six decades, marine fish production in India has increased from 0.5 million tonnes (m t) in 1950 to 3.9 m t in 2012. This trend is different from that of global decadal growth rate, which consistently decreased from the year 1970. However, there are several sustainability concerns that demand immediate as well as long-term solutions. Overcapacity of fishing fleet, overexploitation, pollution and habitat degradation are some of the factors that need to be addressed to sustain marine fisheries.

Long-term climate change will affect the ocean environment and its capacity to sustain fishery stocks and is likely to exacerbate the stress on marine fish stocks. The extent to which it will affect fisheries, in different regions and species, is however not yet clear. Productivity might increase or decrease significantly. Ecosystem boundaries may be displaced and species composition may change remarkably. Fisheries infrastructures may have to be displaced, at high cost. Fisheries lacking mobility (e.g. small-scale traditional fisheries) might suffer the most.

Impact on marine fish

Marine ecosystems are not in a steady state, but are affected by the environment, which varies on many spatial and temporal scales. Fish populations respond to the variation in different ways. As examples, during short term weather changes such as storms, fish may take refuge from rough conditions through minor changes in distribution. Interannual or El Niño scale changes in the ocean environment may result in changes in the distribution patterns of migratory fishes and can affect reproduction and recruitment in other species. Decadal and longer scale variations may have other impacts, potentially including cyclic changes in the production level of marine ecosystems in ways that may favor one species or group over another.

Temperature is one way we measure ocean variability, but temperature is also an indicator of more complex ocean processes. Changes in temperature are related to alterations in oceanic circulation patterns that are affected by changes in the direction and speed of the winds that drive ocean currents and mix surface waters with deeper nutrient rich waters. These processes in turn affect the abundance and variety of plankton which are food for small fish. The biological responses to those ocean processes are complex and not well understood.

Many tropical fish stocks, for instance, are already exposed to high extremes of temperature tolerance, and hence, some may face regional extinction, and some others may move towards higher latitudes. Coastal habitats and resources are likely to be impacted through sea level rise, warming sea temperatures, extremes of nutrient enrichment (eutrophication) and invasive species. Most fish species have a narrow range of optimum temperatures related to their basic metabolism and availability of food organisms. Being poikilotherms, even a difference of 1°C in seawater may affect their distribution and life

processes. At shorter time scales of a few years, increasing temperature may have negative impacts on the physiology of fish because oxygen transport to tissues will be limited at higher temperatures. This constraint in physiology will result in changes in distributions, recruitment and abundance. Changes in timing of life history events (phenological changes) are expected with climate change. Species with short-life span and rapid turnover of generations such as plankton and small pelagic fishes are most likely to experience such changes. At intermediate time scales of a few years to a decade, the changes in distributions, recruitment and abundance of many species will be acute at the extremes of species' ranges. Changes in abundance will alter the species composition and result in changes in the structure and functions of the ecosystems. At long time scales of multi-decades, changes in the net primary production and its transfer to higher trophic levels are possible. Most models show decreasing primary production with changes of phytoplankton composition to smaller forms, although with high regional variability.

Generally, the more mobile species should be able to adjust their ranges over time, but less mobile and sedentary species may not. Depending on the species, the area it occupies may expand, shrink or be relocated. This will induce increases, decreases and shifts in the distribution of marine fish, with some areas benefiting while others lose. From the recent investigations carried out by Indian Council of Agricultural Research, the following responses to climate change by different marine species are discernible in the Indian seas (Vivekanandan, 2011): (i) Changes in species composition of phytoplankton at higher temperature; (ii) Extension of distributional boundary of small pelagics; (iii) extension of depth of occurrence; and (iv) phenological changes.

These changes may have impact on nature and value of fisheries (Perry et al., 2005). If small-sized, low value fish species with rapid turnover of generations are able to cope up with changing climate, they may replace large-sized high value species, which are already showing declining trend due to fishing and other non-climatic factors (Vivekanandan et al., 2005). Such distributional changes would lead to novel mixes of organisms in a region, leaving species to adjust to new prey, predators, parasites, diseases and competitors (Kennedy et al., 2002), and result in considerable changes in ecosystem structure and function.

Currently, it is difficult to find out how much of catch fluctuation is due to changes in fish distribution and phenology. A time series analysis on stock biomass of different species along the Indian coasts does not exist. Long-term records of the abundance for most species are limited to historical commercial landings. Moreover, availability of time series data on climatic and oceanographic parameters and fish catches in India may be too short to detect displacements of stocks or changes in productivity. Moreover, these records are often influenced by economic factors such as the relative price paid for different types of fish, and changes in fishing methods or fishing effort. For instance, introduction of mechanized craft in the 1960s, motorized craft, high opening trawlnet, minitrawl and ringseine in the 1980s, and large trawlers for multiday fishing in the 1990s substantially increased the fish catch along the Indian coast. These non-climatic factors often obscure climate related trends in fish abundance. Perhaps a de-trending analysis for removing the impact of non-climatic factors may help arrive at conclusions on the impact of climate change on marine fisheries.

The effects of changed fish migrations and distribution caused by climate variability and climate change are likely to be most difficult to deal with for highly migratory species, such as tuna. Climate plays a large role in determining short-term, seasonal and multi-year patterns of variability in the location and productivity of these optimal tuna habitat zones. It is not clear whether the spurt in yellowfin tuna fishery in the Bay of Bengal and eastern Arabian Sea in the last five years is due to climate driven changes in the migration route of the fish. We have to find answers to several questions. What will be the influence of rising seawater temperature on the bombay duck, whose northern boundary is landlocked? The sex of sea turtles is critically determined by the soil temperature at which the embryo develops. Temperature above 28° C produces only females. How the turtles would adopt to this crisis? Will there be species succession of phytoplankton with the domination of temperature tolerant species? Is the massive intrusion of pufferfish and medusae into the Indian coastal waters in recent years a fall out of climate change?

Future Research

Evolving models to understand impacts of climate change

In India, marine fish catch and effort data are available for the last five decades. However, a synergy between climatic and oceanographic data and fisheries data does not exist. Projections on climate change impact on fish populations have not been performed so far. Such projections need to be developed as the first step for future analytical and empirical models, and for planning better management adaptations.

Biswas et al (2005) developed a method for forecasting of fish catch of the major fishing areas in the world oceans under higher temperatures. This method predicts the tendency (increase or decrease) for fish catch, with quantitative predictor's power, if the temperature is known. This method has been applied to the Indian Ocean to assess the climate-change impact on fish catch. Based on the temperatures predicted using the CLIMate-BiospheRE model for the years 2000–2100, a decrease of fish catch in the Indian Ocean, with the confidence of the predictor's power at $\geq 90\%$, has been predicted.

Cheung et al (2008, 2010) developed a new computer model that predicts what might happen under different climate scenarios to the distribution of commercially important species. Using a model that tracked a range of habitat conditions, including water temperature and depth from sea ice, to predict which habitats would be most impacted by climate change, they found that around 50 species of commercial fishes living near or at the poles will go extinct within the next 4 decades. Those species that can will try migrating toward the Arctic and Southern oceans or end up trapped in closed seas. While fisheries species in colder waters succumb to climate change, those living in tropical waters will be stressed by overfishing.

Mass-balance models – Ecopath, Ecosim and Ecospace

Many climate change impacts on individual populations will have cascading effects throughout the ecological communities in an ecosystem. The broad ecological impact of climate change can be estimated using the whole food web trophodynamic modelling suite Ecopath with Ecosim and Ecospace. This modelling tool has three complimentary modules

(www.ecopath.org): (1) Ecopath is a static mass-continuity description, or accounting, of trophic flows in any given ecosystem and time period using biomass as a currency. It is a food web model in which all species in the system are aggregated into functional groups whose biomasses, production rates, consumption rates, physiological efficiencies, and diet compositions are estimated and specified, and includes flows to and from fisheries. (2) Ecosim uses information in Ecopath dynamically so that temporal changes in mortality or other physiological rates can be specified to simulate impacts of changes in fisheries exploitation or environmental changes, or both simultaneously. Ecosim allows physiological rates to be changed with climate change. (3) Ecospace enables the expression of Ecosim in a spatially-explicit form for the spatial exploration of biological impacts of an environmental or fisheries change. Ecospace can be used to explore impacts of changes in the distribution of biomasses of each functional group based on how they interact with each other spatially.

There are four approaches that are fruitful for characterising climate change impacts using the Ecopath with Ecosim modelling approach (Richardson and Okey, 2006): (1) constructing and balancing future Ecopath models using estimated biomasses and physiological rates for a future scenario, information from climate envelope and other biophysical models, and comparing the projected to the present day system; (2) producing a time series of fitting error terms that represent non-fisheries impacts (e.g. environmental change) for comparison to integrated ocean climate indicators; (3) forecasting change using Ecosim based on estimated responses of functional groups to particular scenarios of change; and (4) explicitly integrating functional response models within the Ecopath with Ecosim modeling approach.

However, Ecopath has not been extensively used for understanding the impact of climate change as it is not directly connected to hydrodynamic models.

Adaptation options for fisheries

Options for adaptation are limited, but they do exist. The impact of climate change depends on the magnitude of change, and on the sensitivity of particular species or ecosystems (Brander, 2008). In the context of climate change, the primary challenge to the fisheries and aquaculture sector will be to ensure food supply, enhance nutritional security, improve livelihood and economic output, and ensure ecosystem safety. These objectives call for addressing the concerns arising out of climate change, and evolve adaptive mechanisms and implement action across all stakeholders at national, regional and international levels (Table 1; Allison et al., 2004; Handisyde et al., 2005; Leary et al., 2006; World Fish Center, 2006; FAO, 2008). In response to shifting fish population and species, the sector may have to respond with the right types of craft and gear combinations, on-board processing equipments etc. Governments should consider establishing Weather Watch Groups and decision support systems on a regional basis. Allocating research funds to analyze the impacts and establishing institutional mechanisms to enable the sector are also important. The relevance of active regional and international participation and collaboration to exchange information and ideas is being felt now as never before. Action plans at regional level need to be taken by

- strengthening regional organisations and place climate change agenda as a priority;
- addressing transboundary resource use; and
- evolving common platforms and sharing the best practices.

Action plans at international level also need to be taken by

- linking with mitigation activities;
- enhancing co-operation and partnerships; and
- applying international fishery agreements.

Table 1. Options for adaptation with climate change in fisheries and aquaculture (after Allison et al., 2004; Handisyde et al., 2005; FAO, 2008)

Concerns	Adaptive mechanisms
Uncertainties in fish availability and supply	i) Develop knowledge base for climate change and fisheries and aquaculture; ii) Predict medium and long term probabilistic production iii) Assess the adaptation capacity, resilience and vulnerability of marine production systems; iv) Adjust fishing fleet and infrastructure capacity; v) Consider the synergistic interactions between climate change and other issues such as overfishing and pollution
New challenges for risk assessment	i) Consider increasing frequency of extreme weather events; ii) Consider past management practices to evolve robust adaptation systems; iii) Identify and address the vulnerability of specific communities; iv) consider gender and equity issues
Complexities of climate change interactions into governance of frameworks to meet food security	i) Recognition of climate-related processes, and their interaction with others; ii) Action plans at national level based on (a) Code of Conduct for Responsible Fisheries, (b) Integrated ecosystem approach to fisheries and aquaculture management plans, (c) framework for expansion of aquaculture, (d) linkage among cross-sectoral policy frameworks such as insurance, agriculture, rural development and trade iii) Action plans at regional level by (a) strengthening regional organizations and place climate change agenda as a priority, (b) addressing transboundary recourse use, (c) evolving common platforms and sharing the best practices iv) Action plans at international level by (a) linking with mitigation activities (b) enhancing co-operation and partnerships, (c) applying international fishery agreements

Fisheries and aquaculture may be more vulnerable in conflicts with other sectors	<ul style="list-style-type: none"> i) Action plans should involve not only fisheries institutions/departments, but also those for national development planning and finance; ii) Sharing and exchange of information with other sectors; iii) Existing management plans for fisheries and aquaculture need to be reviewed and further developed by considering climate change.
Financing climate change adaptation and mitigation measures	<ul style="list-style-type: none"> i) Fishermen, fish farmers, processors, traders and exporters should increase self protection through financial mechanisms; ii) Improving equity and economic access such as microcredit should be linked to adaptation responses; iii) Investment on infrastructure, such as construction of fishing harbour, should consider climate change; iv) Financial allocation in national budget for risk reduction and prevention practices such as early warning systems and disaster recovery programmes and for relocation of villages from low lying areas; v) Incentive for reducing the sector's carbon footprint and other mitigation and adaptation options

Adopt Code of Conduct for Responsible Fisheries

Fishing and climate change are strongly interrelated pressures on fish production and must be addressed jointly. Moderately-fished stocks are likely to be more resilient to climate change impacts than heavily-fished ones. Reducing fishing mortality in the majority of fisheries, which are currently fully exploited or overexploited, is the principal means of reducing the impacts of climate change (Brander, 2007). Reduction of fishing effort (i) maximizes sustainable yields, (ii) helps adaptation of fish stocks and marine ecosystems to climate impacts, and (iii) reduces greenhouse gas emission by fishing boats (Brander, 2008). About 1.2% of global oil consumption is used in fisheries, and it is found that fish catching is the main contributor to global warming in the fish production chain (Thrane, 2006). Hence, some of the most effective actions which we can tackle climate impacts are to deal with the familiar problems such as overfishing (Brander 2008), and adopt Code of Conduct for Responsible Fisheries and Integrated Ecosystem-based Fisheries Management (FAO, 2007). In India, mechanisms for managing large-scale commercial fisheries such as total allowable catch (TAC) or total allowable effort (TAE) do not exist. Hence, it is a challenge to fully comply with the CCRF. The challenge becomes severe considering the poverty prevalent among the coastal communities involved in traditional fishing methods, and the lack of suitable alternate income generating options for them. These factors make these communities highly vulnerable to climate change, as their capacity to adapt is very limited. Effort to reduce dependence on fishing by these vulnerable communities is essential. It is essential to adopt Ecosystem-based Fisheries Management by integrating fisheries management into coastal areas management.

Understanding the Indigenous Technical Knowledge

Fishing communities have often developed adaptation and coping strategies to deal with fluctuating environmental conditions. Greater understanding of how communities cope with and adapt to fisheries with extreme natural variations would assist in developing adaptation strategies for climate change. Fishermen in India are generally able to track seasonal and spatial variations in fish stock availability and relate it to climatic and oceanographic variabilities. They are able to detect some of the variables such as speed and direction of wind and current, watermass movement and upwelling, and make short-term predictions on fish distribution, spawning and abundance. This knowledge enables them to switch their fishing activities with respect to species exploited, location of fishing grounds and gear used. Gaining an insight into this and advantageously use their ITK to evolve coping mechanism will be useful.

Develop knowledge-base for climate change and marine fisheries

Considerable effort should be made for gathering historic climatic and oceanographic data in addition to monitoring these key parameters to suit climate change research. It is also important to recognize the importance of changes in these parameters as drivers of change in marine communities including fish. Initiating a commitment on long-term environmental and ecological monitoring programmes is important as such data cannot be collected retrospectively. These programmes should develop fisheries models and lead into risk assessment of future fish stock variations and likelihood of resource collapses; and evolving sectoral and food security plans.

Climate change risk assessments

It is important to conduct climate change risk assessments estimate the cost of adaptation of fisheries sector under different climate scenarios. The current and future risks and mechanisms within communities may be identified. The communities should be engaged together with governmental and non-governmental agencies in preparedness planning.

In India, 458 (of the total 2132) coastal fishing villages with a population of one million are located within 100 m from the high tide line (CMFRI, 2009). Risk reduction initiatives such as early warning systems, disaster recovery programmes and reducing risk exposure by enhancing coastal defences are in place. Along the east coast where storms and floods are relatively regular, the governments take preparative action and organize sufficiently to relocate the people temporarily and to restore key services and economic functions. Fishermen receive up-to-date weather forecasts and weather warnings through television, radio and print media, thereby reducing the number of vessels caught at sea by cyclones. Along 400 km of Kerala's 590 km coastline, coast protection structures such as sea walls and gyrones are in place. However, coastal communities often complain incursion of sea through the open, undefended coast. Cost-effective engineering solutions for conservation of erodable shorelines to prevent damage to properties and human life need to be put in place. Risk reduction plans concerning coastal and flood defences should be linked with disaster management.

Increase awareness on the impacts of climate change

Being a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), India has submitted the first National Communication to the UNFCCC in 2004. The second National Communication is under preparation for submission in 2011. National climate change response strategies are under preparation on a sectoral basis. Specific policy document with reference to the implications of climate change for fisheries needs to be developed for India. This document should take into account all relevant social, economic and environmental policies and actions including education, training and public awareness related to climate change. Effort is also required in respect of raising awareness of the impact, vulnerability, adaptation and mitigation related to climate change among the decision makers, managers, fishermen and other stakeholders in the fishing sector. Resilience of fishing communities needs to be enhanced by supporting existing adaptive livelihood strategies. The relative risk of climate change also needs to be understood in the context of impacts on other hazards such as poverty, food insecurity, epidemic diseases, inequity and intrasectoral conflicts.

For the fisheries and aquaculture sector, climate change notwithstanding, there are several issues to be addressed. Strategies to promote sustainability and improve the supplies should be in place before the threat of climate change assumes greater proportion. While the fisheries sector cannot do much to mitigate climate change, it could contribute to reduce the impact by following effective adaptation measures.

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Ecosystem Approach to Marine Fisheries Management

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Background

Sustainable use of living marine resources must consider both the impacts of the ecosystem on the living marine resources, and the impacts of fishery on the ecosystem. This holistic approach to fisheries management has been termed as “ecosystem based fisheries management” (EBFM). Similar holistic management approach in fisheries management have been differently termed as Ecosystem considerations (EC), Ecosystem approach to fisheries (EAF), Ecosystem based management (EBM), Ecosystem Management (EM) etc by various authors. While these are not synonyms, the basic approach stems from the adoption of a perspective encompassing the entire ecosystem. Christie et al. (2007) has recently reviewed about the subtle differences in the meaning of these acronyms.

A lot of attention has recently been directed at assessing the impacts of fisheries on whole marine ecosystems (Pikitch et al., 2004). This has in part been driven by the need to ensure conservation of biological diversity and sustainable use of the biosphere, key provisions of the convention agreed at the UN Rio summit (Tasker et al., 2000). The utilization of sound ecological models and indicators as tools in the exploration and evaluation of ecosystem health and state has been encouraged and endorsed by the leading bodies in ecosystem-based fisheries research and management (ICES, 2000). The potential of the available dynamic ecosystem models to make measurable and meaningful predictions about the effects of fishing on ecosystems has not however been fully assessed. Let us first look at some of the science behind the need for EBFM.

Impacts on Fished Taxa

Harvesting alters ecosystem structure in ways that are only beginning to be understood. It is argued that long-term heavy commercial harvesting is likely to shift the ecosystem to high-turnover species with low trophic levels (Pitcher and Pauly, 1998). The biological mechanism underlying species shifts is that the relatively large, long-lived fishes

which have low mortality rates are more strongly affected by a given fishing mortality rate than are smaller fishes which are part of the same community. A second shift-inducing biological mechanism is habitat degradation caused by various fishing gears, especially bottom trawls. Here, the effect is through destruction of bottom structure, depriving benthic fishes of habitats and prey.

Thirdly, the above and the fishery induced reduction of predatory pressure by benthic fish, may then lead to an increase of small pelagic fish and squids which becomes available for exploitation. This may mask the decline in catches of the demersal groups. In the Gulf of Thailand, in Hong Kong Bay and other areas of the South China Sea, extremely heavy trawl pressure has resulted in a shift from valuable demersal table fish such as croakers, groupers and snappers to a fishery dominated by small pelagics used for animal feed and invertebrates such as jellyfish and squids.

These mechanisms almost often lead, through a positive feedback loop, to a fourth biological mechanism: harvesting small pelagic fish species at lower trophic levels reduces the availability of food for higher trophic levels, which then decline further, releasing more prey for capture by a fishery that finds its targets even lower down the food web, a process now occurring throughout the world (Pitcher and Pauly, 1998). The growing abundance of arrowtooth flounder (*Atheresthes stomias*) in Alaska has been a concern for a decade, while the recent explosion of Humboldt squid (*Dosidicus gigas*) off the U.S. west coast and the high densities of spiny dogfish (*Squalus acanthias*) in New England and the U.S. Atlantic states have led to calls for “ecosystem”-based predator control (Hilborn, 2011). Punt and Butterworth (1995) used trophic models to evaluate the potential to improve fish yields by culling seals. Some examples of such documented species shifts in exploited multispecies fish communities are shown in Table 1.

Table 1: Examples of documented shifts towards smaller, high-turnover species in exploited multispecies communities (modified from Pitcher and Pauly, 1998)

Fishing grounds/ Stocks (period)	Documented species shift
Gulf of Thailand Demersal stocks (1960-1980)	Overall biomass reduced by 90%; residual biomass dominated by trash fish
Philippine shelf Small pelagics (1950-1980)	Gradual replacement of sardine-like fishes by anchovies
Carigara Bay, Philippines All fish (1970-1990)	Fish replaced by jellyfish, now an export item
Black Sea	Small pelagics and jellyfish replace large table fish
North Sea	Halibut and small sharks extinct; cod and haddock threatened; demersal omnivores and small pelagics favoured

Humboldt Current, Chile	Large hake depleted, small pelagics favoured
North Pacific	First marine mammal depletions, followed by huge trawl fisheries: Pollock favoured
South China Sea, Hong Kong	Croakers and groupers almost extinct; small pelagics bulk of fishery
Northwest Coast and Southeast Coast of India	Decline in large predators such as sciaenids, perches and Bombay duck and increase in abundance of oil sardine

Single Species Assessments

The tools developed for single species population dynamics are an essential part of any new methodology. Detailed information on growth, mortality and recruitment schedules and their associated errors and uncertainties are essential for the implementation of the ecosystem approach advocated in the Rio summit.

When considering the management of single components of the ecosystem, such as the target fish stocks, it is possible to set target and limit reference points for particular measurable properties of the species. For example, the implementation of precautionary fisheries management in the North Atlantic has progressed through the setting of reference points for various measures of the status of the exploited species, e.g. the spawning stock biomass (SSB). Two types of reference point are considered - a limit reference point and a target reference point. Management measures are aimed at achieving the target reference point in the medium term and ensuring that the limit reference point is never exceeded.

In theory, it should be possible to apply reference points to any or all taxa in the ecosystem. ICES (2000) have contended that even if this was practical for a significant number of taxa, it may not ensure adequate protection of all the ecosystem components at risk. There is a need, therefore, to develop reference points for system level emergent properties as a measure of ecosystem health (Hall, 1999; Gislason et al., 2000).

ECOSYSTEM MODELLING USING TROPHIC INTERACTIONS

There are many recent developments in building of trophic models of aquatic ecosystems. Such modelling can now be performed more rapidly and rigorously than ever before, providing a basis for viable and practical simulation models that have real predictive power (Christensen and Pauly, 1993; Walters et al., 1997). This was made possible by the development of Ecopath (Polovina, 1984; Christensen and Pauly, 1992), for construction of mass-balance models of ecosystems, based mainly on diet composition, food consumption rates, biomass and mortality estimates.

Ecopath applications to ecosystems, ranging from low latitude areas to the tropics, and from ponds, rivers, and lakes to estuaries, coral reefs, shelves, and the open sea, but all using the same metrics, allowed identification of several general features of aquatic ecosystems:

Multivariate comparisons demonstrated the basic soundness of E. P. Odum's (1969) theory of eco-system maturation (Christensen, 1995), including a confirmation of his detailed predictions regarding ecosystems near carrying capacity (Christensen and Pauly, 1998). Conversely, this theory can now be used to predict the effect of fisheries on ecosystems, which tend to reduce their maturity, as illustrated by the comparison of Ecopath models for the Eastern Bering Sea in the 1950s and early 1990s (Trites *et al.*, 1999), and to guide ecosystem rebuilding strategies implied in "Back to the Future" approaches (Pitcher, 1998; Pitcher *et al.*, 2000).

PERFORMANCE MEASURES

It is generally agreed that reductions in single species fishing mortality levels is perhaps the most significant step one could take towards ensuring the persistence of marine ecosystems (Hall and Mainprize, 2004). It is also clear that ecosystem based fisheries management is still in its formative years, although substantial developments have been seen in some countries and regions. Among these, North America, Antarctica, Europe, Australia and New Zealand are the most notable. Probably the most advanced implementation of EBFM in the US context is the North Pacific Fisheries Management Council approach.

Table 2. The six principles for an ecosystem based fisheries management approach (adapted from Inter-agency Marine Fisheries Working Group, 2002)

Principle	Description
Ecosystem identification	The ecosystem that fisheries will be managed within need to be defined on the basis of the main physical, biological and human dependency relationships
Clear objectives	Objectives for fisheries management shall have regard to local and national needs, and management should be decentralized to the maximum extent possible
Long term benefits	EBFM should aim for long term benefits – management should look to restore stocks to levels that are capable of delivering optimal yields over the long term; and achieving such yields should not compromise other marine species and habitats. Management should also aim to support biological biodiversity
Incentives aligned with and ecosystem based approach	Incentives should be realigned to support aims of the ecosystem based approach – incentives and financial support needs to be redirected from fisheries that aim at increasing

fishing efficiency to those that make concerted efforts to those that promote the restoration of fish stocks to optimal yield levels and which support responsible fishing practices in sensitive marine areas

Easily assessed information and alternate management options

Information necessary to implement the ecosystem based approach should be made available to all. Where information is insufficient, adaptive management and the precautionary approach should be followed. If the outcome falls short of what was intended the management decisions should be suitably altered – proactive management

Unfortunately, despite the legislative imperative and clearly articulated principles (Table 2), arriving at an operational framework for an ecosystem based approach to fisheries management is fraught with difficulties. This difficulty is due, not only to the inherent challenge in establishing and quantifying the effects of fishing at an ecosystem level, but also due to the social and political dimensions associated with harvesting fisheries at an environmentally sustainable level.

THE TWO ASPECTS OF EBFM

Very recently, (Hilborn, 2011), classified EBFM as consisting of a core and extended EBFM. The “core” consists of three primary features: (a) doing single species management right, i.e., keeping fishing mortality at or below f_{MSY} , and keeping fleet capacity in line with the potential of the resources, (b) preventing by-catch of non-target species, which can be achieved by gear modification, providing incentives for by-catch avoidance, or by area and seasonal closures, and (c) the avoidance of habitat modifying fishing practices primarily by closing areas or banning of specific fishing methods or gears in sensitive areas. Consideration of trophic interactions and area-based management characterize “extended” EBFM. There are two elements of “extended” EBFM that are underway. One is founded in detailed studies, as exemplified by wide-scale multi-species data collection on food habits and trophic connections sometimes combined with ecosystem models. There are now ecosystem models for many ecosystems. It is possible that ecosystem models will be used to identify “problem” species and potentially direct fisheries to deliberately reduce their abundance.

The second element of extended EBFM is area-based management. Examples of existing area-based management include closed areas to protect spawning stocks, juvenile fish or sensitive habitats (Worm et al., 2009). There is a growing use of area-based management to reduce by-catch, such as short term closures in the eastern Bering Sea and the North Sea (National Research Council, 2003), or the larger and longer closures to protect cod in New England and rockfish off California. There is also the implementation of large-scale systems of marine protected areas in many parts of the world. Area based management is currently a reality, and it is certainly going to continue to expand. Nevertheless, the cost of ecosystem models and area-based management is very high. Just doing stock assessments for every species instead of the current practice of the economically

important ones will likely require a multi-fold increase in science and management costs. Integrated Ecosystem Assessment (IEA) has emerged (Levin et al., 2009) as one approach to solve the problem, by seeking important indicators of ecosystem condition rather than tracking all species in the ecosystem. Rather than doing single species assessment for each species, simpler ecosystem based indicators could be used in the management control rules.

EBFM IN ASIAN CONTEXT

Application of EBFM implies a balanced approach to addressing ecosystem wellbeing and thus contributes positively to biodiversity, governance and human wellbeing aspects in order to contribute to social development and poverty alleviation and many Asian countries have adopted this principle. EBFM is very useful in situations where conflict resolution is required. All Asian countries have EBFM aligned activities and there are many initiatives that are aimed at implementing the CCRF. For example, India has stated in its Marine fishery Policy of 2004 that marine fisheries management should be placed in the context of EBFM. Many traditional systems have practices that broadly conform to EBFM principles but are not recognized as “Ecosystem-based” approaches and there is a lack of appreciation of what is already being done. EBFM can also be used for addressing adaptation/resilience of fisheries and aquaculture to climate change impact/effects. Each country has its own context for policy development and resource allocation, therefore implementation of EBFM will differ depending on that context. Many countries note that existing legislation and/or policy may not explicitly support the EBFM and will require amendment or updating.

A regional consultative workshop on practical implementation of the Ecosystem Approach to Fisheries and Aquaculture in the APFIC region was held at Jeju, Republic of Korea, 6-8 September 2010 and adopted an action plan and recommendations from APFIC Regional Consultative workshop on “Practical Implementation of the Ecosystem Approach to Fisheries and Aquaculture” held at Colombo, Sri Lanka during 18-22 May 2009. Member countries were of the view that mainstreaming EBFM as a national system for management requires strong commitment of government and other relevant stakeholders.

The Fisheries Improved for Sustainable Harvest (FISH) project in the Philippines is likely the first EBFM project in the tropics and is at early stages of implementation. The FISH project is a seven-year effort focused on strengthening the capability of local and national institutions to manage coastal resources and marine fish stocks (www.oneocean.org). It is funded with an eight million dollar grant from 2003–2010 from the US Agency for International Development (USAID) to the Philippine government with technical assistance provided by Tetra Tech EMI, a private consultant agency, and other institutions (e.g., University of Washington).

India has also taken the initiative to construct models of trophic interactions of food webs of some of the important aquatic ecosystems. For example the Arabian Sea off Karnataka has been modeled (Mohamed et al., 2008) and preliminary ecological simulations have been done to aid fisheries policy (Mohamed and Zacharia, 2009). Similarly an inland reservoir has been modeled and changes in management policy were compared on a

temporal basis (Panikker and Khan, 2008). Similar modeling exercises are also underway in Thailand and Malaysia.

FUTURE OF EBFM

Hilborn (2011) predicts two possible futures for EBFM that are not mutually exclusive. The core elements of EBFM, getting single-species fishing mortalities right, reducing by-catch, and protecting sensitive habitats, are widely accepted, being implemented, and are reasonably inexpensive. This will mean lowering fishing mortality on all species below the levels that produce MSY and probably lowering even more the exploitation rates on forage species. Various agencies are now using various ecosystem indicators to modify their regulations (Fletcher et al., 2010). Essentially, ecosystem impacts of competition and predation are ignored when single-species assessments are used on a stand-alone basis. This aspect of EBFM could significantly modify management since the U.S. and many other countries use estimates of unfished biomass when making harvest decisions.

The second phase of EBFM is true ecosystem-based control rules, supported by ecosystem models and ecosystem indicators. Hilborn (2011) states that this second phase will not occur for many years because of the high cost and lack of ecosystem-based objectives. There is a great deal of science going into using ecosystem indicators (Smith et al., 2007; Fletcher et al., 2010) and there is little sign of implementation and acceptance with ecosystem models replacing current single species models.

Lastly, EBFM does need to take account of the role of people in the ecosystem. Much of the current implementation of EBFM relates primarily to the natural ecosystem and regulation of harvest and gears are the key control variables. Another major element of fisheries management is allocation of access to fishing. There is considerable dispute over this area of fisheries management, and allocation often consumes as much management energy as does harvest regulation. Meanwhile, increasing evidence points to an interrelation between how fish are allocated and the ecosystem consequences of fishing (Costello et al., 2008). These new vistas need to be studied in the Asian and tropical seas context, but it is quite clear that the holistic EBFM is the way forward in fisheries management and conservation.

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Present scenario of captive breeding, seed production of Marine ornamental fishes for its sustainable management and trade.

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Introduction

The marine ornamental fish trade is a global multimillion dollar industry worth an estimated US\$ 200 - 330 million annually and operated throughout the tropics. The Philippines, Indonesia, Solomon Islands, Sri Lanka, Australia, Fiji, the Maldives and Palau supplied the major share of marine ornaments during the recent years. The United States, the United Kingdom, the Netherlands, France and Germany were the most important countries of destination.

Unlike freshwater ornamental fishes, where the trade is mainly contributed by species that are farmed, the marine ornamental fishes are obtained from wild collections. Since the tropical marine aquarium fish and invertebrates in the trade are directly exploited from the coral reefs, long term sustainability of the aquarium industry is a controversial aspect. The damaging techniques such as the use of sodium cyanide used for wild collection, the over harvesting of target organisms and the high level of post harvest mortality are the major constraints associated with the trade of marine ornamentals based on wild collection. But if managed properly, the aquarium industry could support long term conservation and sustainable use of coral reefs. Management of marine ornamental fisheries has to be implemented in such a way that they are biologically sustainable, do not conflict with other resources and keep post harvest mortalities to the minimum. Habitat damage and negative impact to the ecosystem have to be avoided. Species that are unsuitable to aquaria should not be collected. It is evident from the global scenario of the marine ornamental trade that even though the trade is very lucrative and is expanding rapidly, the problems involved are complex and requires appropriate management strategies.

In India only about Rs. 3 crores worth of ornamental fishes are traded annually and they are contributed mainly by indigenous freshwater species collected from rivers. About 85% of ornamental fish exported from India are from North Eastern Region. Recent studies have revealed that Kerala has a rich biodiversity of freshwater ornamental fish fauna represented by 125 species. The Western Ghats has 85 endemic taxa of ornamental fishes.

In India, till date no organized trade of marine ornamentals has been initiated. But it is a fact that a great deal of illegal collection of marine ornamentals is in vogue in many parts of our reef ecosystem and this is a matter of great concern due to the indiscriminate nature of exploitation and eco hostile methods of collection which damage the reef ecosystem. In addition to this, lack of knowledge on appropriate post harvest husbandry practices leads to large scale mortality of the collected animals. It is time to evolve a marine ornamental fisheries policy in our country for developing an organized trade of marine ornamentals. It is felt that eventhough the ideal situation is to develop a sustainable trade of marine ornamentals through tank reared species, it has to be admitted that development of commercial level breeding technologies of all the species of demand will take a very long time and if you have to wait till then, we may fail to enter into this lucrative global trade in the near future.

Suggestion for management of Marine ornamental ecosystem in India.

- ❖ A critical analysis of current global trade of the marine ornamentals from wild collections reveals many ecological concerns which require policy interventions.
- ❖ Appropriate action to ensure that the development of the trade should not threaten the sustainability of the coral reef ecosystem.
- ❖ The destructive collection practices such as use of cyanide should be banned by legislation and enforcement. Results from a recent study demonstrated that colonies of commonly traded species of corals and soft corals to varying concentrations of cyanide over different periods of time caused mortality in all corals. *Acropora*, the genus which is specifically targeted by fishers for collection of fish as they tend to hide amongst its braches is most vulnerable to cyanide exposure, showing rapid signs of stress and bleaching (Cervino, *et.al.* 2003).
- ❖ Exploitation on population due to selective harvesting of species which are of high demand in the trade. Here also policy intervention through legislation has to play a key role. Several countries in Asia and South America have begun to implement collection restrictions on certain ornamental fish species (Corbin and Young, 1995; Friedlander, 2001; Ogawa and Brown, 2001). Although no marine species collected for the aquarium trade have been driven to global extinction, studies carried out in Sri Lanka, Kenya, the Philippines, Indonesia, Hawaii and Australia have reported localized depletion of a number of targeted aquarium species due to heavy collection pressure. Studies have also shown that removal of larger quantities of cleaner wrasses and cleaner shrimps which play key roles in reef health creates negative impacts on reef diversity.
- ❖ Exploitation of species which are not suited for aquarium. This also needs to be avoided by legislation.
- ❖ Regulations to post harvest mortality. Research on marine ornamental trade between Sri Lanka and the United Kingdom demonstrated that in mid 1980's about 50% fish died during and immediately after collection and another 10% during transport, and the rest 5% in holding facilities (Wood, 1985). As a result of such mortally more fish often need to be collected for meeting the market demand.
- ❖ Training may be imparted for handling and transportation individuals and transported in suitable containers to avoid post harvest mortality.

- ❖ The post harvest conditioning facilities should include modern gadgets such as UV lighting system, protein skimmers and carbon filters, etc.
- ❖ The impact of exploitation has to be closely monitored by scientific agencies at periodic intervals and required management measures have to be implemented as and when required.
- ❖ Few number of entrepreneurs can be licensed to collect suitable species from selected areas using eco-friendly collection methods. Availability of necessary infrastructure and technical know-how for conditioning and maintaining of harvested species should be one of the prerequisites for issuing license to an entrepreneur.

In the light of the above it is evident that while developing a marine ornamental industry in India it is inevitable to formulate legislations on these issues which are of vital concern to the sustainability of the trade. The Central Marine Fisheries Research Institute (CMFRI) and the National Bureau of Fish Genetic Resources (NBFGR) can combine to develop a certification system on line with standards developed by the Marine Aquarium Council (MAC). The Marine Products Exports Development Authority (MPEDA) can take the lead to develop an export market for the certified varieties.

Scenario in marine ornamental fish breeding in India.

India is endowed with more than 200 varieties of export oriented marine ornamental fishes and it is widely accepted that their wild collection from the flimsy reef ecosystem will lead to habitat damage and overexploitation of the species which are in high demand. In this context, the only alternative for the development of a long term sustainable trade of marine ornamental fishes is through hatchery production. The decline of exploited marine fishery resources due to increasing fishing pressure, the set back in shrimp farming due to disease outbreak and the impact of the tsunami have adversely affected the livelihood of Indian coastal villagers and an alternative livelihood option is felt very essential. Considering these situations, during the past few years, the Central Marine Fisheries Research Institute (C.M.F.R.I.) and Fisheries Division of Central Agriculture Research Institute (CARI) of ICAR have intensified research activities on breeding and culture of marine ornamental fishes. The development of hatchery technology for 20 species of marine ornamental fishes such as clown fishes *Amphiprion percula* (True percula/ clown anemone fish) Madhu and Rema, 2000; *A. ocellaris* (Common Clown/ False clown anemonefish) Rema *et al.*, 2012; *A. sandaracinos* (Yellow Skunk Clown) Rema and Madhu, 2012; *A. frenatus* (Tomato clown) Madhu *et al.*, 2011, *A. clarkii* (Clark's Anemonefish), *A. nigripes* (Maldives Anemonefish) (Madhu and Rema Madhu, 2006; Madhu *et al.*, 2006a,b,c; Rema Madhu, *et al.*, 2007; Madhu *et al.*, 2008). Madhu and Rema, 2011; *A. perideraion* (Pink anemone fish) (Anil *et al.*, 2012), *Amphiprion ephippium* (redsaddle back anemone fish), *A. sebae* (Sebae clown) (Gopakumar, *et al.*, 2007, 2009); and *Premnas biaculeatus* (Maroon clown/ Spine cheek anemone fish) Madhu *et al.*, 2012. and dotty back *Pseudochromis dilectus* (Redhead Dottyback) were bred. The species such as

damsels *Dascyllus trimaculatus* (Three spot damsel); *D. aruanus* (Striped damsel); *Pomacentrus caeruleus* (Blue damsel); *P. pavo* (Sapphire or Peacock Damsel); *Neopomacentrus nemurus* (Yellow tail damsel); *N. filamentosus* (Filamentous tail damsel); *Chrysiptera cyanae* (Sapphire devil); *C. unimaculata* (One spot damsel) and *Chormis viridis* (Green chromis) (Gopakumar, *et al.*, 2007, 2009, Syda Rao *et.al.*, 2010); under captivity for the first time in India.

It is well accepted that the trade developed from tank reared fish and other ornamentals is the final solution for a long term sustainable trade. The economic viability of ornamental fish production is more lucrative when compared to other mariculture species, due to their high unit value. The complete package of practices developed for their production can be taken up as an alternative livelihood option for small and large scale fish farmers. The transfer of technology to the public and private sector entrepreneurs who have approached for the technology is being planned by imparting hands on training through different modes under the Consultancy Processing Cell (CPC) of the CMFRI and organized trainings. In addition, the hatchery produced seeds are also being sold to the farmers and aquarium hobbyists and traders through Single Window System and seed counters are in operation in marine hatcheries of CMFRI at Cochin and Mandapam. This has resulted in the emergence of several ornamental fish trade shops all over the country. The National Fisheries Development Board (NFDB) has also developed schemes to fund for ornamental fish culture in the unutilized hatcheries of the prawn farmers in India. In the near future India can emerge as one of the leading international traders of marine ornamental fishes through hatchery production.

The ultimate answer to a long term sustainable trade of marine ornamental fishes can be achieved only through the development of culture technologies. At present tank reared species contribute only 1-2% of the trade. Culture of marine ornamental fish is well accepted as an environmentally sound way to increase the supply of such organisms by reducing the pressure on wild populations and producing juvenile and market size of a wide variety of species year round. In addition, hatchery produced fish are hardier which fare better in captivity and survive longer So that DOA (Death on Arrival) will be less while transporting.

In the immediate future India can emerge as one of the major source countries for a sustainable marine ornamental trade by formulating appropriate policy regulations for wild collection of species and also by commercial production of suitable species though the development of hatchery technologies for selected species.

In this context, establishment of an oceanarium in the country will be of much significance for the education, research and conservation of the marine biodiversity especially the coral reef ecosystem. The declaration of specified areas as marine reserves where the collection of marine ornamentals is made illegal is one of the effective conservation measures. Setting up quotas and size limits and restricting access to the ornamental fishery through the use of permits can also reduce exploitation pressure. Third party certification of the trade, whereby the consumer is empowered to assist in the reduction of the environmental impact of the trade by selectively purchasing ornamentals collected in an environmentally friendly manner, has been recommended as a possibility for improved conservation management.

Governments and industry itself can play an important role in promoting best practice for a sustainable marine ornamental fish trade.

Marine Aquarium Council (MAC)

In this context, the core standards developed by the Marine Aquarium Council (MAC, 2001). The certification scheme has also developed which will track an animal from collector to hobbyist. With a network of 2600 stakeholders in more than 60 countries, it is recognized as the lead organisation for developing and co-ordinating efforts to ensure that the international trade in ornamental marine organisms is sustainable. Industry operators can be certified through an evaluation for compliance with the appropriate MAC standard for the certification of practices. The MAC core standards include the ecosystem and fishery management core standard, the collection, fishing and holding core standard and handling, husbandry and transport core standards. The core standards are accompanied by best practice guidance documents that provide advice to the industry operators on how they might be able to comply with the standards. Another important aspect of this certification programme is the establishment of a monitoring system within collection areas to ensure early detection of any changes to fish population resulting from collection for the trade.

Regulations are in vogue in many countries regarding the introduction of exotics and GMOs. As the international trade of ornamental fishes is bound to increase in the coming years, this issue is of prime importance. The absence of proper regulatory mechanisms regarding the introduction of exotics and GMOs, coupled with the absence of aquatic quarantine mechanisms in India, can increase the risks of exotic disease establishment and threaten the indigenous populations. Recently the Ministry of Agriculture entrusted the task of formulating the national strategic plan guidelines for Aquatic Exotics and Quarantine to National Bureau of fish Genetic Resources (NBFGFR). NBFGFR has issued two special publications namely 'National Strategic plan for Aquatic Exotics and Quarantine' and 'Aquatic Exotics and Quarantine guidelines' for promoting introductions while safeguarding biodiversity and preventing economic loss. Evolving appropriate machinery for following these guidelines will be very much essential in future for the development of a safe and sustainable ornamental fish trade in India.

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Mariculture Technologies for enhancing livelihood options in the Coastal Sector

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Introduction

Aquaculture, the fastest growing food-producing sector, is perceived as having the greatest potential to meet the growing demand for aquatic food. The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals for human consumption continues to grow, and reached 52.5 million tonnes in 2008. The contribution of aquaculture to the total global fish production continues to increase, rising from 34.5% in 2006 to 36.9% in 2008. The average annual per capita supply of food fish from aquaculture has increased by ten times from 0.7kg in 1970 to 7.8 kg in 2008 at an average rate of 6.6 % per year. Worldwide, the sector has grown at an average rate of 8.3 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems over the same period.

Mariculture- the farming and husbandry of marine plants and animals in the marine environment - has contributed 32.3% of the global aquaculture production by quantity and 30.7% of the total value. Mariculture produces many high value finfish, crustaceans, and molluscs like oysters, mussels and clams. Hence it is evident that in the context of declining catch rate from capture fisheries on a global basis, the development and expansion of mariculture has the potential to augment seafood production.

Mariculture -Indian scenario

The dwindling catch rates in capture fisheries and rampant unemployment in the coastal region focus towards the development of mariculture and coastal aquaculture as a remunerative alternate occupation. Recent estimates quantify the per capita fish consumption in India around 8-10kg per year and is likely to grow to 16.7kg by 2015. Although about 1.2 million hectares are suitable for land based saline aquaculture in India, currently only 13 % is utilized. Farmed shrimp contributes the major share in the total shrimp export. The farming of shrimp is largely dependent on small holdings of less than 2 hectares, as these farms account for over 90% of the total area utilized for shrimp culture.

Coastal aquaculture is mainly concentrated in the states of Andhra Pradesh, Tamil Nadu, Orissa and West Bengal. In recent years, the demand for mussels, clams, edible oysters, crabs, lobsters, sea weeds and marine finfishes is continuously increasing and brings premium price in the national and international markets. The long coastline of 8129 km along with the adjacent landward coastal agro climatic zone and the sea-ward inshore waters with large number of calm bays and lagoons offer good scope to develop mariculture in the country.

Coastal aquaculture is a significant contributor to sea food production, constituting mainly the shrimps like *Penaeus monodon* and *Litopenaeus vannamei*. However, vast water bodies highly suitable for aquaculture and the varied biodiversity that has the potential to capture new markets with a wide range of seafood products, have prompted consideration of other candidate species like oysters, mussels, crabs, lobsters, sea bass, cobia, pompano, groupers, ornamental fishes and sea weeds in the new aquaculture scenario in the country. In this context, the Central Marine Fisheries Research Institute (CMFRI) is the pioneering institution in the country which has initiated mariculture research and has been developing appropriate mariculture technologies in India. In India till date mariculture activities are confined only to coastal brackish water aquaculture, chiefly shrimp farming. The other coastal aquaculture activities are green mussel farming which is confined to Malabar Coast in Kerala producing more than 15,000 tonnes and seaweed farming along Ramanathapuram and Tuticorin coasts of Tamil Nadu producing about 5000 tonnes annually.

The potentially cultivable candidate species in India include about 20 species of finfishes, 29 crustaceans, 17 molluscs, 7 seaweeds and many other species of ornamental and therapeutic value. Many mariculture technologies are very simple, eco-friendly and use only locally available infrastructure facilities for construction of farm, feed and seed and hence the entire farming can be practiced by traditional fishermen. Another advantage is that most of our brackish and coastal areas are free from pollution and suited for aquaculture. But hardly 10% of the potential cultivable area is presently used for aquaculture in spite of growing demand for cultured shrimp, bivalves, crabs, and lobsters etc., all of which are in high demand in the export market. In addition a fast growing trade of marine ornamental fishes and other tropical marines has also emerged in the recent years which open up the possibility of culture and trade of these organisms.

Existing major mariculture species and farming technologies Shrimp seed production and culture

Shrimps being a highly valued export commodity, shrimp farming is considered a lucrative industry. Depending on the area of the pond, inputs like seed, feed and management measures like predator control, water exchange through tidal effects or pumping, etc., farming systems have been classified into four groups: extensive, modified extensive, semi-intensive and intensive. The farming community has now become more responsive to the concepts of environment-friendliness and sustainable aquaculture. Disease problems are being overcome through adoption of closed system of farming (recirculation system, zero water exchange) in grow outs, application of probiotics, secondary aquaculture of selected fishes like mullets, milkfish, molluscs and seaweeds in reservoirs and drain canals, adoption of indigenous, good quality seed and feed and

reduction in stocking density. Currently, farming of the white shrimp *Litopenaeus vannamei* has gained momentum in India and is contributing to the bulk of farmed shrimp production.

Lobster farming and Fattening

Increasing demand for live lobsters in the export market led the farmers and entrepreneurs to collect juvenile lobsters from the wild and grow to marketable size in ponds and tanks by feeding trash fishes and other discards. In many maritime states juvenile lobsters of *Panulirus homarus*, *P. ornatus* and *P. poyphagus* are grown in captivity and the eyestalk ablated lobsters attained 180 – 200 g in 5 – 6 months period. This type of lobster fattening at a stocking density of 10 – 15 young ones per square meter yielded appreciable growth rates with a profit margin of Rs.50, 000/- from a pond of 70 m². Fattening and grow out trials with artificial pellet feeds has been successfully completed. Cage farming of spiny lobsters was successfully demonstrated by CMFRI at Vizhinjam, Veravel and Mandapam. Recently major breakthrough in breeding and hatchery production of two species of scyllarid lobsters, *Thenus orientalis* and *Petrarctus rugosus* was achieved. Successful hatchery production of seeds of *T. orientalis* and its compatibility with *F. indicus* at high density race way culture system with very high production rates of 3-5kg/sq.m is highly promising.

Crab farming/ fattening

Live mud crabs (*Scylla serrata*, *S. tranquebarica*) being a much sought after export commodity, mud crab fattening is considered the best alternative. Seed stock consist of freshly moulted crabs (water crabs) of 550 g which are stocked in small brackishwater ponds at a stocking density of 1/sq. m or in individual cages for a period of 3-4 weeks while being fed thrice daily with low value fish @ 5-10 per cent of their biomass. Selective harvesting is done according to size, growth and demand and the venture is profitable because of low operating costs and fast turnover. Monoculture (with single size and multiple sizes stocking) and polyculture with milkfish and mullets are being carried out on a small scale, as the seed supply is still mainly from the wild. Hatchery methods for breeding and seed production of the blue swimming crab, *Portunus pelagicus*, have also been developed. Fattening and grow out trials with artificial pellet feeds has been successfully completed.

Edible Oyster Farming

CMFRI has developed methods for edible oyster (*Crassostrea madrasensis*) culture and has produced a complete package of technology, which is presently being widely adopted by small scale farmers in shallow estuaries, bays and backwaters all along the coast. In the adopted rack and ren method, a series of vertical poles are driven into the bottom in rows, on top of which horizontal bars are placed. Spat collection is done either from the wild or produced in hatcheries, on suitable cultch materials. Spat collectors consist of clean oyster shells (5-6 Nos.) suspended on a 3 mm nylon rope at spaced intervals of 15-20 cm and suspended from racks, close to natural oyster beds. Spat collection and further rearing is carried out at the same farm site and harvestable size of 80 mm is reached in 8-10 months. Harvesting is done manually with a production rate of 8-10 tonnes/ha. Oyster shells are also in demand by local cement and lime industry.

Mussel Farming

The Institute has developed technologies for culture of bivalves like raft method (in bays, inshore waters), rack method (in brackishwater, estuaries) or long line method (open sea) are commonly adopted for mussel farming (*Perna indica* and *P. viridis*). Mussel seeds of 15-25 mm size collected from intertidal and sub tidal beds are attached to coir/nylon ropes of 1-6 m length and enveloped by mosquito or cotton netting. Seeds get attached to rope within a few days while the netting disintegrates. The seeded ropes are hung from rafts, racks or long lines. A harvestable size of 70-80 mm is reached in 5-7 months and production of 12-14 kg mussel (shell on) per metre of rope can be obtained. Commercial level mussel farming is being practiced at Malabar Coast, Kerala which produces around 15,000 t annually.

Pearl Oyster Farming and Pearl Production

In India, the marine pearls are obtained from the pearl oyster, *Pinctada fucata*. Success in the production of cultured pearls was achieved for the first time in 1973 by CMFRI. Raft culture and rack culture in nearshore areas are the two methods commonly adopted for rearing pearl oysters and recently attempts have been made to develop onshore culture methods. Shell bead nucleus (3-8 mm) implantation is done in the gonads of the oyster through surgical incision while graft tissues are prepared from donor oysters of the same size and age group. Implanted oysters are kept under observation for 3-4 days in the labs, under flow- through system and then shifted to the farm in suitable cages for rearing. Periodic monitoring is done and harvest is carried out after 3-12 months. Pearls are categorized into A, B and C types depending on colour, luster and iridescence. Research is also directed towards development of a technology for *in vitro* pearl production using mantle tissue culture of pearl oyster. The technology for mass production of pearl oyster seed has also been developed. Village level pearl oyster farming and pearl production, through direct involvement of small scale fishermen have been carried out as part of technology transfer programme along the Valinokkam Bay on the east coast. Recently success has been obtained in the production of Mabe pearls and tissue culture of pearls. Success was achieved in the organ culture of mantle of pearl oyster and abalone. Research efforts are being carried out for the production of tissue culture pearls. Mabe pearl production was standardised for production of base images. Technology for production of jewellery from Mabe pearl was also standardised. However, marine pearl production still remains to be commercialized in India.

Clam Culture

Package of clam culture practices has been developed for the blood clam *Anadara granosa* and *Paphia malabarica*, where production of 40 tonnes/ ha/6 months and 15-25 tonnes/ha/4-5 months have been achieved in field trials. Induced spawning and larval rearing to setting of spat has been perfected for clams like *P. malabarica*, *Meretrix meretrix* and *Marcia opima*.

Abalone Culture

Abalones are marine gastropods of the genus *Haliotis*. They are known for the production of gem quality pearls and also for their succulent meat. *Haliotis varia* is the

commercially important species along the Indian coast. CMFRI has developed methods for the seed production and culture of this species.

Marine Finfish Culture

Mariculture of marine finfish has been growing rapidly on a global basis especially with the development and expansion of sea cage farming. One of the major reasons for the growth of sea cage farming is the availability of breeding techniques that can produce sufficient quantity of seeds of different high value marine finfish. Many countries in the Asia-Pacific Region like Australia, China, Japan, Taiwan, Philippines, Indonesia, Thailand, Malaysia and Vietnam have made substantial progress in the development of commercial level seed production technologies of high value finfish suitable for sea farming. In all these countries, the success could only be possible due to the establishment of controlled broodstock development. In India much research attention is not yet given for developing seed production methods for high value finfishes suited for sea farming. At present, we have commercial seed production of only one marine finfish – sea bass (*Lates calcarifer*). Here also private entrepreneurship has not yet been developed. The major bottlenecks in achieving commercial level seed production are the control of reproductive processes of fish in captivity and production of bio-secure and quality-certified fry. Broodstock management usually includes collection, selection and domestication of brooders as well as control of maturation and spawning and egg collection. The broodstock developed in sea cages is susceptible to the changes in the water quality of the cage site, disease problems and impact of harmful algal blooms. Consequently the broodstock developed in sea cages is not bio-secure and hence can lead to spreading of diseases while farming is taken up on a commercial basis. If the broodstock development and larval production is practiced in recirculation systems, it is possible to have control on the environment in which the broodstock and larvae are produced. Recirculation systems use land based units to pump water in a closed loop through fish rearing tanks and include a series of sub-systems for water treatment which include equipments for sterilization, heating or cooling, solid removal, water chemistry control, biological filtration and dissolved gas control. Sustainable production of bio-secure marine finfish seed all through the year employing photo-thermal conditioning is possible only by recirculating systems and this facility can pave the way for the commercial level seed production.

Cobia and pompano aquaculture

Cobia (*Rachycentron canadum*) and silver pompano (*Trachinotus blochii*) are two marine finfish species with very high potential for aquaculture in India. Fast growth rate, adaptability for captive breeding, lowest cost of production, good meat quality and high market demand especially for *sashimi* industry are some of the attributes that make cobia an excellent species for aquaculture. In recent years the seed production and farming of cobia is rapidly gaining momentum in many Asian countries. Envisaging the prospects of cobia farming in India, broodstock development was initiated at the Mandapam Regional Centre of Central Marine Fisheries Research Institute in sea cages during 2008 and the first successful induced breeding and seed production was achieved in March – April 2010. Trials on sea cage farming carried out at Mandapam showed that the fishes attained an average weight of 2.5 kg in six months and 7.3 kg in twelve months. The species can be grown in low salinity and experiments revealed that upto 15ppt the growth and survival is comparable to that in seawater. These results point out the possibility of developing a

lucrative cobia aquaculture enterprise in the country. However, standardization of technologies for seed production and farming of cobia to suit our environmental conditions have to be further pursued on a priority basis so that India can also emerge as a contributor for cobia production in the near future.

Similarly among the many high value marine tropical finfish that could be farmed in India, the silver pompano is also one of the topmost, mainly due to its fast growth rate, good meat quality and high market demand. The species is able to acclimatize and grow well even at a lower salinity of about 10 ppt and hence is suitable for farming in the vast low saline waters of our country besides its potential for sea cage farming. At Mandapam Regional Centre of CMFRI, successful broodstock development, induction of spawning and fingerling production of silver pompano was achieved during July 2011 for the first time in India. Subsequently two more seed production experiments were also done successfully and now farming trials are progressing. This can be considered as a milestone towards the development of pompano aquaculture in the country. The current achievements in cobia and pompano can be considered as the first step towards the aquaculture development of the two species. The establishment of biosecure broodstock centres, standardisation of breeding, larviculture and nursery rearing protocols and farming demonstrations in pond and sea cages are the steps to the way forward. Hence it is required to invest and establish infrastructure for the different phases from seed to product development *viz.* Required broodstock facility for the production of viable fertilised eggs throughout the year (ii) hatchery facility for meeting the seed requirements (iii) grow out facilities and (iv) product processing and distribution system. It is felt that both cobia and pompano are potential aquaculture giants having vast domestic and global business prospects.

Marine Ornamental Fish Culture

On a global basis a lucrative marine ornamental fish trade has emerged in recent years which have become a low volume high value industry. There are a wide variety of ornamental fishes in the vast water bodies and coral reef ecosystems along the Indian coast, which if judiciously used, can earn a sizeable foreign exchange. A long term sustainable trade of marine ornamental fishes could be developed only through hatchery produced fish.

The Central Marine Fisheries Research Institute has intensified its research on breeding, seed production and culture of marine ornamental fishes. One of the milestones in this programme is the recent success in the hatchery production technology of clown fish. Success was also obtained on the broodstock development, larval rearing and seed production of 7 species of damselfishes. The marine ornamental fishes for which breeding and seed production technologies were developed by CMFRI are the following.

- 1) *Amphiprion sebae*
- 2) *Amphiprion percula*
- 3) *Amphiprion ocellaris*
- 4) *A. nigripes*
- 5) *A. ephippium*
- 6) *Premnas biaculeatus*
- 7) *Pomacentrus pavo*
- 8) *Neopomacentrus nemurus*
- 9) *Dascyllus aruanus*
- 10) *Dascyllus trimaculatus*

11) *Pomacentrus caeruleus*

12) *Chrysiptera cyanea*

The technologies developed have to be scaled up and demonstrated for commercial level production. Hatchery production and culture of marine tropical ornamental fish can prove to be more economically feasible than that of marine food fish culture, due to the high price per unit of ornamental fish. The clown fishes and damselfishes of the family Pomacentridae offer immediate scope for hatchery production due to the availability of seed production methodologies.

Development of a Sustainable Trade

A critical analysis of current global trade of the marine ornamentals from wild collections reveals many ecological concerns which require policy interventions. The major aspect that should receive top most priority is for taking appropriate action to ensure that the development of the trade should not threaten the sustainability of the coral reef ecosystem. The following measures are suggested.

(i) Regulation for Collection from the wild

The destructive collection practices such as use of cyanide should be banned by legislation and enforced. Results from a recent study demonstrated that colonies of commonly traded species of corals and soft corals to varying concentrations of cyanide over different periods of time caused mortality in all corals. *Acropora*, the genus which is specifically targeted by fishers for collection of fish as they tend to hide amongst its branches is most vulnerable to cyanide exposure, showing rapid signs of stress and bleaching (Cervino, *et.al.* 2003). Another aspect of concern is the impact of exploitation on population due to selective harvesting of species which are of high demand in the trade. Here also policy intervention through legislation has to play a key role. Several countries in Asia and South America have begun to implement collection restrictions on certain ornamental fish species (Corbin and Young, 1995; Friedlander, 2001; Ogawa and Brown, 2001). Although no marine species collected for the aquarium trade have been driven to global extinction, studies carried out in Sri Lanka, Kenya, the Philippines, Indonesia, Hawaii and Australia have reported localized depletion of a number of targeted aquarium species due to heavy collection pressure. Studies have also shown that removal of larger quantities of cleaner wrasses and cleaner shrimps which play key roles in reef health creates negative impacts on reef diversity. The third aspect of concern is the exploitation of species which are not suited for aquarium. This also needs to be avoided by legislation. The fourth aspect which demands regulations is regarding the post harvest mortality. Research on marine ornamental trade between Sri Lanka and the United Kingdom demonstrated that in mid 1980's about 50% fish died during and immediately after collection another 10% during transport and 5% in holding facilities (Wood, 1985). As a result of such mortality more fish often need to be collected for meeting the market demand. Where organisms are collected, stored and handled by adequately trained individuals and transported in suitable containers fish mortality have been very low. The post harvest conditioning facilities should include modern gadgets such as UV lighting system, protein skimmers and carbon filters.

(ii) Introduction of certification for wild collected species

Marine Aquarium Council (MAC) has developed a certification scheme that will track an animal from collector to hobbyist. Established in 1996, the goals of MAC are to develop standards for quality products and sustainable practices and a system to certify compliance with these standards, and create consumer demand for certified products. With a net work of 2600 stakeholders in more than 60 countries, it is recognized as the lead organization for developing and coordinating efforts to ensure that the international trade in ornamental marine organisms is sustainable. MAC certification covers both practices and products.(Bunting *et al*, 2003)

Industry operators can be certified through an evaluation for compliance with the appropriate MAC standard for the certification of practices. For certification of products MAC certified marine ornamentals must be harvested from a certified collection area and pass from are certified operations to another. MAC – certified marine organisms bear the “MAC-certified” label on the tanks and boxes in which they are kept and shipped.

Concept of a small-scale hatchery

Small-scale hatcheries for marine ornamental fish are those where the capital costs and technologies are accessible for relatively low cost which focuses on broodstock development, larviculture, nursery rearing and grow-out to marketable size. The small-scale hatcheries can be easily adapted to culture a range of different species.

Advantages of small-scale hatcheries

1. Low capital inputs
2. Simple construction
3. Ease of operation and management
4. Flexibility
5. Quick economic returns.

A typical small-scale hatchery for marine ornamental fish consists of the following units.

1. Broodstock tanks
2. Larviculture tanks
3. Nursery rearing and grow-out tanks
4. One sand filter
5. Outdoor live feed (Phyto and zooplankton) production tanks
6. Seawater and freshwater supply system.

Technical assumptions for production

It is assumed to be an indoor system located in a coastal area with access to both salt and freshwater and easy transportation access to market.

The analysis will focus on an integrated culture system of broodstock, hatchery, larval rearing/nursery and grow-out.

There are 12 broodstock pairs. At any time there are 10 active spawning pairs. Each pair will spawn 2 times per month. An average of 400 larvae is produced during each spawn. The survival rate of the larvae to transfer to grow out phase is 50%. The period from larvae to juvenile is 30 days.

There is a 60% survival rate for juveniles to market size, which are saleable. The period from nursery to market size is 120 days. In a month, 240 saleable sized fishes can be produced from one pair of clown fish. Each fish can be sold at a rate of Rs.100.

The sale of the fishes will start from second year onwards. The first year of operation will be construction and set up of the building, procurement of equipment and collection and maintenance of brooders. The first spawning is expected in eighth month of first year. The first harvest and sale will occur at the first month of second year.

Site Selection

A site suitable for a small-scale marine ornamental fish hatchery should have the following characteristics:

- (i) Good water source – both seawater and access to freshwater
- (ii) Good infrastructure such as road, electricity, etc.
- (iii) Free from industrial and other pollution

Hatchery lay out

The hatchery should be laid out in such a way that it provides for ease of operation and it should also be free from work hazards. The essential types of tanks required for a small-scale hatchery are the following:

i) Sand filter tank:

Small-scale hatcheries may use a gravity sand filter to initially remove coarse particles and organisms from the source water. Such filter tanks are usually made of concrete and the filter medium comprises a layer of coarse material such as stones at the bottom and gravel and sand layers respectively. The water inlet to this filter is at the top of the tank to allow water to filter from top down before going to the larval rearing tank.

ii) Broodstock tanks

Broodstock tanks are generally cement tanks, rectangular or square in shape. They range in size from 0.3 to 0.5 m³ capacity. Usually, the depth of broodstock rearing tanks is 0.6m in depth. Cement tanks should be painted internally with food grade epoxy paint to prevent the leaching of cement and other chemicals into water.. It is better to paint the inside of the tanks with dark colours.

ii) Larval rearing tanks:

Larval rearing tanks are generally cement tanks, rectangular or square in shape. They range in size from 0.3 to 0.5 m³ capacity. Usually, larval rearing tanks are 0.5m in depth, but nursery tank can range between 0.5-1 m deep. All cement tanks used in hatcheries need to be finished internally with food grade epoxy paint to prevent the water from coming in direct contact with the cement. It is better to paint the inside of the tanks with blue or green colour.

iii) Live feed production tanks

Microalgae production tanks normally make up about 30% of the total production volume of a small-scale hatchery. These tanks are usually located outside the hatchery and are not roofed. Capacity varies from 1.0m³ to 2.0m³.

Generally the rotifer culture area will take up about 10% of the total hatchery area. Rotifer tanks can be 1.0 -2.0 m³.

Artemia are hatched in fiberglass or plastic tanks. These tanks range from 20 to 500 litres.

Hatchery equipment and accessories:

i) Water Pump:

Two types of pumps are required for the small-scale hatchery operation. A pump of 5HP is required to pump seawater to the hatchery's sand filter tank. A separate submersible pump is required to distribute water within the hatchery system.

ii) Generator:

A generator of 1 KVA is essential as backup electricity supply for the hatchery.

iii) Aeration system:

Small 100 watt air pump with at least one backup is needed.

iv) Other hatchery equipments

1. An ordinary microscope.
2. Thermometer
3. Salinometer
4. pH meter
5. Water analysis kit
6. Hand nets
7. Plastic wares like buckets, bins, hoses etc.

v) Manpower:

The small scale hatchery can be managed by two full time staff – One technician and two workers. Basic training on technical aspects is needed for day-to-day hatchery operation. Daily routine works include cleaning broodstock and larval tanks, feeding broodstock and larval tanks, harvesting microalgae, rotifers, *Artemia* etc.

Economic Assessment

The candidate species selected for economic analysis is the true clown *Amphiprion percula*.

Capital Investment

This component involves all the expenditure on the infrastructure and establishment of the hatchery. The items included in this component generally have a life span larger than one year and they are used to generate the future income from the hatchery. The items include

Capital Investment items	Quantum	Cost in Rupees
Temporary Shed	144m ² (12 X 12m)	1,10,000
Cement tanks for		3,40,000
i. Broodstock	12	
ii. Larval rearing	12	
iii. Nursery and grow out	18	
iv. Microalgae (outdoor)	4	
v. Rotifer (outdoor)	3	
vi. Sand filter /Over head tank	1	

Artemia hatching tanks (Transparent Perspex)	3	10,000
Power installation		10,000
4 HP diesel pump	1	19,000
1/2 HP submersible pump	1	6,000
Generator 2 KVA	1	30,000
Air pumps	2	40,000
PVC piping, plastic wares (water supply/aeration/drainage)		45,000
Netting, miscellaneous etc.		40,000
TOTAL COST		6,50,000

Operating expenses

This component is for the expenses that are spent during each production cycle and are essential for the routine operation of the hatchery.

The items included are:

	Items	1 st year	2 nd year	3 rd year
1.	Broodstock fishes/ Anemone	25,000	5,000	5,000
2.	Feeds	12,000	12,000	12,000
3.	Artemia	4,000	12,000	12,000
4.	Chemicals for microalgal culture	6,000	6,000	6,000
5.	Electricity	36,000	36,000	36,000
6.	Diesel	24,000	24,000	24,000
7.	Maintenance	12,000	18,000	18,000
8.	Workers salaries (1xRs. 5000; 2xRs.3000)	1,32,000	1,32,000	1,32,000
9.	Miscellaneous expenditures	12,000	12,000	12,000
	TOTAL	2,63,000	2,57,000	2,57,000

Non-operational expenses

These are related to the capital cost and investments write off. There are two items under this component for small-scale hatcheries.

- i) Depreciation
- ii) Interest on capital investment

The sale of the fishes will start from second year onwards. The first year of operation will be construction and set up of the building, procurement of equipment and collection and maintenance of brooders. The first spawning is expected in eighth month of first year. The first harvest and sale will occur at the first month of second year.

	Amount in Rs.		
	Year 1	Year 2	Year 3
Revenue Sale of clownfish fingerlings @ Rs.100/fingerlings (240 juveniles x 10 pair x12 month =28,800 numbers 28800 x Rs 100 = Rs. 2880000)		28,80,000	28,80,000
Non operating expenses			
a. Depreciation (20%)	1,30,000	1,30,000	1,30,000
b. Interest rate on capital investment @12%	78,000	78,000	78,000
Operating cost	2,63,000	2,57,000	2,57,000
TOTAL EXPENSES	4,71,000	4,65,000	4,65,000
Profit	-----	24,15,000	24,15,000
Pay back period	5.28 months		

Profit and Loss

This consists of the revenue generated from sales of clownfish young ones minus all the operating and non-operating expenses. The payback period can be used to measure how rapidly to small-scale hatchery can provide a return to the farmers or investors.

$$\begin{aligned}\text{Payback period (PP)} &= (\text{Capital Investment} / \text{Profit}) \times 12 \text{ months} \\ &= (6.5/14.53) \times 12 = 5.28\end{aligned}$$

Return on investment or payback period for the small-scale hatchery based on the above calculations is about six months. It is evident that the capital invested for the small-scale hatchery can be recovered fully within six months from the start of earning. The only assumptions made are that the hatchery operations are running smoothly and the price of *A.percula* juveniles remain stable during the period.

Seaweed Culture

Around 60 species of commercially important seaweeds with a standing crop of one lakh tonne occur along the Indian coast from which, nearly 880 tonnes dry agarophytes and 3,600 tonnes dry alginophytes are exploited annually from the wild. Seaweed products like agar, algin, carrageenan and liquid fertilizer are in demand in global markets and some economically viable seaweed cultivation technologies have been developed in India by CMFRI and Central Salt and Marine Chemical Research Institute (CSMCRI). CMFRI has developed technology to culture seaweeds by either vegetative propagation using fragments of seaweeds collected from natural beds or spores (tetraspores/ carpospores). It has the potential to develop in large productive coastal belts and also in onshore culture tanks, ponds and raceways. The rate of production of *Gelidiella acerosa* from culture amounts to 5 tonnes dry weight per hectare, while *Gracilaria edulis* and *Hypnea* production is about 15

tonnes dry weight per hectare. Recently the culture of the carageenan yielding sea weed *Kappaphycus alvarezii* has become very popular due to its fast growth and less susceptibility to grazing by fishes and is being cultivated extensively along the Ramanathapuram and Tuticorin coasts of Tamil Nadu .

Culture Techniques

In Tamil Nadu coast, floating raft method was found to be commercially viable method in *K. alvarezii* farming. Floating raft is made of bamboo with 12' × 12' for mainframe and 4' × 4' for diagonals. In each raft, 20 polypropylene-twisted ropes are used for plantation. The fragments (approximately 150 grams) are tied at a spacing of 15 cm in a rope. Totally, at 20 points the fragments are tied in a rope. Thus, for one raft the plantation requirement is 60 kgs. To protect the *Kappaphycus* from grazing, fishing net of 4m x 4m size is tied at the bottom of the raft. One anchor of 15 kg can hold a cluster of 10 rafts. During rough season two to three anchors are required to hold a cluster of 10 rafts. The unit cost per bamboo raft for seaweed cultivation is Rs.1000/-The farming is taken up for nine months (i.e., February to October) in an year. The crop is ready for harvest after 45 days from planting. From the 45th day, one raft is harvested every day and subsequently planted and floated in the sea. Hence, one crop / cycle duration is 45 days. In the first year, four crops are harvested. During the second and third year, three crops are harvested. On an average three to four crops are harvested in a year.

Average yield per raft (12 x 12 feet) is 240 to 260 kilogram. They retain 60 kilogram as planting material for the next crop. If 240 kg of seaweed is dried, it results in 24 kg dry weight. The current price is ` 3.50 per kilogram on wet weight basis and ` 26.50 per kilogram on dry weight basis. A fisherman family earns around ` 10,000 to 15,000 per month.

Sea cage Farming

The sea cage culture has been expanding in recent years on a global basis and it is viewed by many stakeholders in the industry as the aquaculture system of the millennium. Cage culture has made possible the large-scale production of commercial finfish in many parts of the world and can be considered as the most efficient and economical way of rising fish. The rapid growth of the industry in most countries can be attributed to (i) suitable sites for cage culture (ii) well established breeding techniques that yield a sufficient quantity of various marine and freshwater fish juveniles (iii) availability of supporting industries such as feed, net manufactures, fish processors etc. (iv) strong research and development initiatives from institutions, governments and universities and (v) the private sector ensuring refinement and improvement of techniques/ culture systems, thereby further developing the industry.

Commercial cage culture was pioneered in Norway in the 1970s with the rise and development of salmon farming. As in terrestrial agriculture, the move within aquaculture towards the development and use of intensive cage farming systems was driven by a combination of factors, including the increasing competition faced by the sector for available resources (including water, land, labour, energy) , the drive for increased productivity per unit area and the need for the sector to access and expand into new untapped open water culture sites such as lakes, reservoirs, rivers and coastal brackish and

marine offshore waters. The cage aquaculture sector has grown very rapidly during the past 20 years and is presently undergoing rapid changes in response to pressures from globalization and growing demand for aquatic products. Currently on a global basis commercial cage culture has been restricted to the culture of high value, compound feed fed finfish species, including salmon, Japanese amberjack, red sea bream, yellow croaker, European sea bass, gilthead sea bream, cobia and groupers. Cage culture systems employed by farmers vary from traditional family owned cage farms (Asian countries) to modern commercial large scale salmon and trout cage farms in Northern Europe and Americas. The rapid rise and success of the salmon cage farming industry has been due to a combination of interlinked factors such as the development and use of an easily replicated and cost effective technology (including hatchery seed production), access to large areas of suitable waters, good species selection, market acceptability, increased corporate investment and a good and supportive government regulatory environment.

Marine cage farming is relatively new in Asia and was developed initially in Japan for species such as yellowtail (*Seriola quinqueradiata*) and red sea bream *Pagrus major*. Over the last twenty years the cage farming practice has spread almost throughout Asia. The major cage farming countries are China, Indonesia, Taiwan Province of China and Vietnam. A large number of finfish species are farmed in cages in Asia viz. groupers, snappers, carangids, seabass and cobia. In most countries individual operations are not large, and often a clustering of farming activities, which is due to limited site availability in coastal waters, is seen.

When compared to many countries in the Asia-Pacific Region, India is still in its infancy in sea cage farming. For the first time in India as part of R &D a marine cage of 15 m diameter with HDPE frame was successfully launched and operated at Visakhapatnam, in the east coast of India by the Central Marine Fisheries Research Institute. Eventhough it cannot be taken as a commercially successful venture, a lot of lessons were learnt on designing and fabrication of cages and mooring systems. This has led to the development of better designs of cages of 6m diameter with improved mooring systems that can withstand rough sea conditions. Subsequent demonstrations of cage farming were undertaken along different parts of the Indian coast under a participatory mode with the local coastal fishermen. Successful sea cage farming demonstrations were conducted at Kanyakumari, Vizhinjam, Kochi, Mangalore, Karwar, Veraval, Mandapam, Chennai and Balasore. Sea bass and spiny lobsters were the major groups employed for farming. Recently successful sea cage farming demonstrations were conducted from hatchery produced seeds of cobia and silver pompano at Mandapam. The major steps for the way forward in the development of sea cage farming include (i) selection of suitable sites along our coast for cage farming (ii) establishment of hatcheries for high value finfishes like cobia, pompano, groupers and snappers (iii) development of cost effective cage designs suited to different areas (iv) Evolving appropriate species specific farm management protocols and (v) development of marketing strategies.

Conclusion

It is well recognized that many of our exploited marine fishery resources have already reached the maximum sustainable levels and hence increasing the fishing pressure to

augment the marine fishery resources from Indian seas may not be a viable proposition. In this context, for meeting our future additional demand for sea food, it is inevitable to venture into mariculture practices to meet the additional requirement of sea food as well as for augmenting the income of the coastal fishermen. The development and standardization of commercially viable mariculture activities is the major prerequisite. The available technologies can be popularized by effective extension mechanisms such as participatory demonstration programmes. In this context, the bivalve farming practices, sea weed culture, marine ornamental fish culture and small-scale sea cage farming deserve prime attention. The initiation and expansion of mariculture practices can lead to the increased production of sea food and also augment the income generation of the coastal fishermen in the country.

Marine Mammal Research and Conservation in India

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Abstract

Marine mammals are probably one of the best sentinel organisms in aquatic and coastal environments because many species have long life spans and have extensive fat stores that can serve as depots for anthropogenic toxins. Marine mammals in the Indian EEZ are one of the least studied animals. In India, 26 species of cetaceans and one species of sirenian have been recorded. In recent years, with increasing fishing activity and extension of fishing to oceanic waters, the encounters between fishing gear and marine mammals are on the rise. The Central Marine Fisheries Research Institute (CMFRI) initiated the study of marine mammals in India in the 1950s. Since then the knowledge base on these charismatic animals in the Indian EEZ has substantially increased. This is causing concern in the effort to conserve these mega fauna, which are protected under Wildlife (Protection) Act, 1972. From a vast network of trained field staff located at its research and field centers along the Indian coast, the CMFRI has and published information on occasional stranding, sighting and accidental gear entanglement for more than 60 years. Research on distribution, abundance, species identity, molecular sequencing and fisheries interaction was strengthened after initiating a project on marine mammals in the year 2003. The conservation status of marine mammals in India and the research needs are discussed in the paper in detail.

Introduction

In India, earlier research on marine mammals was restricted mostly to opportunistic collection of information on strandings and beach-cast specimens. Organised research by government and non-government organisations on these charismatic and vulnerable/endangered animals was initiated approximately 15 years ago. In the last 15 years, data on sightings, species inventory, abundance estimates, DNA sequences and fisheries interaction have been collected. These researches have indicated the need for future enhanced research on these sentinel megafauna of the oceans. At present, all species of marine mammals in the Indian seas are placed under Wildlife (Protection) Act, 1972.

Capture, use and trade of marine mammals are punishable under the Act. However, marine mammal – fisheries interaction is a major cause for concern.

Status of research

In India, 25 species of cetaceans and one species of sirenian have been recorded. The Central Marine Fisheries Research Institute (CMFRI) initiated the study of marine mammals in India in the 1950s (Jones, 1959) and has collected and published information on the occasional stranding, sighting and accidental gear entanglement for the last 60 years. Dedicated seminar conducted on endangered marine animals played a pivotal role in creating awareness (Silas, 1985). For an understanding on the cetacean species diversity, distribution and abundance the CMFRI initiated a research project “Studies on Marine Mammals of Indian EEZ and the Contiguous seas” funded by Ministry of Earth Sciences in the year 2003. A Marine Mammal Stranding workshop was conducted by CMFRI in collaboration with NOAA, USA in 2010.

Distribution

Sighting cruises

In the last eight years, 62 opportunistic marine mammal cruises were conducted on board FORV *Sagar Sampada* in the coastal and oceanic waters of Arabian Sea, Bay of Bengal and southern part of Sri Lanka. More than 844 days of survey extending for 8461 hours of observation effort and covering a distance from 1 km to > 1000 km from the shore with a depth range of 20 m to 5000 m have been made. Nearly 727 sighting events consisting of 15,824 individuals were recorded. During the surveys, seven species of whales and ten species of were recorded. Ten species, which were recorded in strandings, could not be encountered in the sighting surveys.

The major conclusions of the sighting surveys are as follows (Afsalet *et al.*, 2008):

1. Marine mammals are widely distributed.
2. Abundance and species richness are high in South Sri Lanka coast followed by Southeastern Arabian Sea (off Kerala – Karnataka).
3. In spite of absence of ten species in the surveys, the general distribution pattern agrees with historical records based on incidental capture.
4. The spinner dolphin *Stenella longirostris* is the most dominant, distributed abundantly in space and time.
5. There is an indication of habitat preference of other species; *Sousa chinensis* and *Tursiops aduncus* are restricted essentially to coastal waters (so also is the finless porpoise) whereas *Tursiops truncatus* inhabits oceanic waters.
6. *Stenella longirostris*, *Sousa chinensis*, *Tursiops aduncus* and *Neophocaena phocaenoides* appear to be the residents or regular visitors to the region.
7. Being residents/regular visitors to the coastal areas, the four species mentioned above are more vulnerable to fishery interactions.

8. Whereas all species were found at SST 26.0 – 30.0°C, *Tursiops aduncus* and *Delphinus capensis* were found at SST as high as 32.0 – 32.9°C.

In spite of valuable information generated from the sighting surveys, there were several limitations:

1. FORV *Sagar Sampada* is too big for sighting cruises; not easily maneuverable; observation deck (17m from sea level) is very high.
2. All cruises were “opportunistic”; not dedicated to mammal surveys.
3. Effort not uniformly distributed; oceanic waters were not well covered and Gulf of Mannar was not covered.
4. Only about 50% of the sightings were identified as ‘confirmed’ or as “possible”.
5. Abundance estimates could not be made.

Strandings

Kumaran (2002) compiled the available reports on the stranding of Indian marine mammals, published by more than 200 authors of 180 papers from the years 1800 to 2000. He found 1452 records all along the maritime states and two island groups. He concluded that the species diversity of marine mammals in India is one among the richest in the Indian Ocean. Large number of records are available on the spinner dolphin *Stella longirostris* (260), common dolphin *Delphinus delphis* (possibly many were *Delphinus capensis*; 256), Indo-Pacific humpbacked dolphin *Sousa chinensis* (221), short-finned pilot whale *Globicephala macrorhynchus* (166) and dugong (165). Most of information pertains to occasional stranding or accidental entanglements in fishing gear, especially gillnets. In many instances, the information is limited to mere morphometric measurements and photographs. Many publications suffer from mis-identification of species.

Incidental catches of marine mammals in the gillnet fishery were used for studying the anatomy (10 species) and stomach contents (11 species). Most of the small cetaceans are opportunistic feeders and the stomach contents of the same species vary with space and time (Kumaran, 2002). Commercially important fish and shellfish were found in the stomach of dolphins.

Marine mammal – fisheries interaction

The marine mammal – fisheries interaction is a major cause for concern. Mechanized fishing was introduced on a commercial scale in India in the mid 1960s. Since then, the fisheries sector has grown rapidly. Marine fisheries census carried out by CMFRI in 2005 shows that there are 58,911 mechanized fishing craft along the Indian coast operating trawlnet, gillnet, lines, dolnet and purse seines. The efficiency of fishing vessels has increased, resulting in longer sea endurance, extension of fishing to oceanic waters and introduction of larger and efficient gear. The growing number and efficiency of mechanized boats have increased the chances of fishing gear – marine mammal encounters. Unfortunately the incidental kills of marine mammals have not been regularly monitored in India. However, it is natural to expect that the incidental kills of marine mammals,

especially those of small cetaceans, would have increased with the proliferation of mechanized fishing fleet.

About 9000 to 10,000 dolphins are estimated to be caught by gillnet annually along the Indian coasts (Yousuf *et al.*, 2008). Gillnet accounted for 68.9% of the catch. The two species commonly involved in the gillnet fishery are the spinner dolphin *Stenella longirostris* and the bottlenose dolphin *Tursiops aduncus*. In addition, other species such as Risso's dolphin *Grampus griseus*, long-beaked common dolphin *Delphinus capensis* and Indo-Pacific humpbacked dolphin *Sousa chinensis* were also reported. Maximum number of dolphin entanglements in gillnet was encountered in the fishery for large pelagics such as tuna (Visakhapatnam and Chennai) and seerfish (Kakinada). The length of gillnet ranged from 0.5 to 6 km. At Periyapatnam (near Mandapam), the mesh size ranged up to 18 cm for catching rays. Off Mangalore, a large number of finless porpoise *Neophocaena phocaenoides* was incidentally caught in purse seines. In the surveyed areas, the overall length of mechanized boats that incidentally caught dolphins and porpoise ranged from 9 to 15 m with 20 to 108 hp engine. The fishing operations were carried out 4 to 70 km from the shore.

Molecular taxonomy of marine mammals

From the samples collected from the carcass of incidentally caught specimens, 63 sequences of cytochrome b gene and control region of mtDNA from 40 individuals of 11 species were deposited in the GenBank (www.ncbi.nlm.nih.gov/). A PCR-based sex determination technique has been developed based on the amplification of genomic DNA extracted from skin samples (Jayasankar *et al.*, 2008).

Bioaccumulation of trace metals

Marine mammals, as top predators, accumulate trace elements in their tissues from their environment, chiefly via their food. Trace metal accumulation depends mainly on the feeding habits, size, length and habitat. Muscle, liver and kidney samples from 33 incidentally caught and stranded marine mammals at six sampling locations showed that the concentrations in the samples were low compared to those from other parts of world.

Bioaccumulation of pesticides

The cetaceans are unique in terms of the great organochlorine 'storage capacity' of their blubber, which act as a reserve for ingested lipophilic (fat-loving) chemical contaminants (such as DDT and PCBs, Dixon). Blubber samples from 37 individuals belonging to eight species were analysed for organochlorine pesticides. The concentrations of Σ HCHs (BHCs), Σ DDTs and Σ chlordanes were generally lower than the values reported from other parts of the world.

Conservation status

The research findings of CMFRI on distribution and abundance of marine mammals from sighting cruises and incidental capture in fishing gear, and the earlier published records, makes it possible to revise the status of different species of marine mammals in the

Indian seas. Table 1 provides only an indicative conservation status based on the available information and is subjected to changes when more data become available. Table 1 also provides IUCN status report for the species occurring in the Indian seas.

Table 1. Conservation status of marine mammals in India

No	Common Name	Species name	IUCN Status	India Status*
1.	Blue whale	<i>Balaenoptera musculus</i> (Linnaeus, 1758)	Endangered	Endangered
2.	Fin whale	<i>Balaenoptera physalus</i> (Linnaeus, 1758)	Endangered	Endangered
3.	Bryde's whale	<i>Balaenoptera edeni</i> Anderson, 1878	Data Deficient	Data Deficient
4.	Common Minke whale	<i>Balaenoptera acutorostrata</i> Lacépède, 1804	Least Concern	Data Deficient
5.	Humpback whale	<i>Megaptera novaeangliae</i> (Borowski, 1781)	Least Concern	Data Deficient
6.	Sperm whale	<i>Physeter macrocephalus</i> Linnaeus, 1758	Vulnerable	Vulnerable
7.	Pygmy sperm whale	<i>Kogia breviceps</i> (de Blainville, 1838)	Data Deficient	Data Deficient
8.	Dwarf sperm whale	<i>Kogia sima</i> (Owen, 1866)	Data Deficient	Data Deficient
9.	Cuvier's beaked whale	<i>Ziphius cavirostris</i> Cuvier, 1823	Least Concern	Data Deficient
10.	Indo-Pacific beaked whale	<i>Indopacetus pacificus</i> (Longman, 1926)	Data Deficient	Data Deficient
11.	Short-finned pilot whale	<i>Globicephala macrorhynchus</i> Gray, 1846	Data Deficient	Data Deficient
12.	Killer whale	<i>Orcinus orca</i> (Linnaeus, 1758)	Data Deficient	Data Deficient
13.	False killer whale	<i>Pseudorca crassidens</i> (Owen, 1846)	Data Deficient	Data Deficient
14.	Pygmy killer whale	<i>Feresa attenuata</i> Gray, 1874	Data Deficient	Data Deficient
15.	Melon-headed whale	<i>Peponocephala electra</i> (Gray, 1846)	Least Concern	Data Deficient
16.	Irrawady dolphin	<i>Orcaella brevirostris</i> (Gray, 1866)	Vulnerable	Vulnerable
17.	Indo-Pacific humpbacked dolphin	<i>Sousa chinensis</i> (Osbeck, 1765)	Near Threatened	Near Threatened
18.	Rough-toothed dolphin	<i>Steno bredanensis</i> (Lesson, 1828)	Least Concern	Data Deficient
19.	Risso's dolphin	<i>Grampus griseus</i> (Cuvier, 1812)	Least	Least

			Concern	Concern
20.	Bottlenose dolphin	<i>Tursiops aduncus</i> (Ehrenberg, 1833)	Data Deficient	Least Concern
21.	Pan tropical spotted dolphin	<i>Stenella attenuata</i> (Gray, 1846)	Least Concern	Data Deficient
22.	Spinner dolphin	<i>Stenellalongirostris</i> (Gray, 1828)	Data Deficient	Least Concern
23.	Striped dolphin	<i>Stenella coeruleoalba</i> (Meyen, 1833)	Least Concern	Data Deficient
24.	Long beaked common dolphin	<i>Delphinus capensis</i> Gray, 1828	Data Deficient	Least Concern
25.	Finless porpoise	<i>Neophocaena phocaenoides</i> (Cuvier, 1829)	Vulnerable	Near Threatened
26.	South Asian River dolphin	<i>Platanista gangetica</i> (Roxburgh, 1801)	Endangered	Endangered
27.	Sea cow	<i>Dugong dugon</i> (Müller, 1776)	Vulnerable	Endangered

* Status assigned based on sighting surveys conducted by the CMFRI during the years 2003-2012 under the project “Studies on marine mammals of Indian EEZ and the contiguous seas” funded by CMLRE, Ministry of Earth Sciences, Government of India

Besides Wildlife (Protection) Act 1972 of India, the seasonal ban on fishing under the Marine Fisheries Regulation Act indirectly protects the marine mammals. Recently, a Task Force for Conservation of Dugong has been constituted by Ministry of Environment & Forests, Government of India.

Need for developing National Action Plan on Marine Mammals

Conservation management action plans are important for maintaining and restore the distribution, abundance and diversity of marine mammals in the Indian EEZ. Developing a National Action Plan on Marine Mammals by constituting a Task Force is keenly felt for India (Vivekanandan *et al.*, 2010). The Task Force for developing NPOA-Marine Mammals may address the following:

1. Reducing incidental kills by fishing gear
2. Bycatch management
3. Establishing marine mammal stranding network
4. Necropsy of beach-cast samples
5. Research needs
6. Non-invasive ecotourism
7. Awareness building

Conclusion

As information on marine mammals is imperative to design and implement meaningful conservation measures, marine mammal research in India should be given priority and should gain a more professional approach.

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Responsible marine fisheries: Reflections from Maharashtra

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Introduction

With average annual marine fish landings of 3.6 lakh t during 2001-10, Maharashtra is one of the major fish producing states ranking 4th in the country. The annual marine fishery potential of the State in the Exclusive Economic Zone (EEZ) is estimated at 6.5 lakh t (Ministry of Agriculture, 1993) while long term potential yield (LTPY) based on the maximum annual landings up to 90 m depth during 2001-2010 is estimated at 5.2 lakh t (CMFRI, 2010). The annual landings valued at about Rs 2,322 Crores contributed 0.5% to the GDP of the state.

The marine fishery along the coast of Maharashtra is multi-species, supported by tropical species with relatively smaller size, fast growth, almost continuous breeding and low volume (biomass) nature with rapid turnovers. Owing to multi-species nature of the fishery resources, the marine fisheries of the state are typically recognized by the gears rather than species, excepting for Bombay duck which is characteristic of the northwest coast of the country. The major traditional fisheries in Maharashtra are bag net ('*dol* net'), drift gill net ('*Tarti*' or '*Daldi*'), bottom set gill net ('*Budi*'), long line ('*Khanda*') and shore seine ('*Rampani*'). In addition, there are variants of these nets and a multitude of local indigenous gears and contrivances which are used in inshore and nearshore waters.

With rapid mechanization that commenced in late 1960, trawling has emerged as the dominant fishing practice with capital base provided by institutional and government support. Trawling targets shrimps, cephalopods and demersal fin fishes that cater to the processing and export industries. The traditional *dol* net and gill net fisheries are well organized by the co-operatives and undergone massive mechanization and motorization as a result major fish landings in the state are contributed by the mechanized and motorized sector and barely 1-2% by the non-mechanized traditional fisheries. The traditional artisanal fishing practiced in inshore areas of the state is unorganized and largely marginalized like subsistence level fishing. In the past decade, purse seine fishery has gained prominence in the state owing to increased abundance of mackerel and oil sardine but at the same time shore seine and long line fisheries though supported by the co-operatives, have significantly

declined and marginalized. The trawlers and purse seiners land large quantity of bycatch (60-65%) comprising of enormous quantity of juvenile, undersized fishes and inedible biota which is discarded at sea and mostly goes unreported. The bycatch and 'discards' have adversely affected the non-mechanized traditional fisheries greatly in the state.

Fishery resources

Maharashtra has 720 km long coastline stretched across five maritime districts, namely Thane, Greater Mumbai, Raigad, Ratnagiri and Sindhudurg. The northern coastal waters along Thane, greater Mumbai and Raigad districts are rich in fish resources of Bombay duck, non-penaeid prawns, golden anchovy, silver pomfret, eels, lobster, ribbon fish, horse mackerel, large sized croakers (*Ghol* and *Koth*) and threadfins (*Rawas* and *Dhara*), some of which are very characteristic of the region. They are mainly exploited by bag nets, surface drift and bottom set gill nets, large trammel gill nets introduced recently and hooks and long lines. The southern coastal waters of Maharashtra along Ratnagiri and Sindhudurg districts abound with the mackerel and sardines in addition to penaeid prawn, seer fish, black pomfret and catfish resources which are caught by shore seines (*Rampani*), gill nets and hooks and lines.

The major fishery resources landed in the state in the past decade were mainly pelagic (34.7%) and demersal (30.2) finfishes, crustaceans (29.8%) and molluscs (5.4%). A decadal comparison showed that excepting for pelagic resources which improved by 9.6%, the rest declined; the demersals by 29.5%, mollusks by 30.4% and crustaceans by 17.6% as against previous decade. The major fishery resources and their contribution to total fish landings are shown in Fig 2.

Gear-wise landings: The estimated landing by different fishing gears is shown Fig 3. It is seen that almost the entire marine fish catch in Maharashtra was landed by mechanized boats (99%) and merely 1% by the non-mechanized crafts in the past decade. The mechanized trawlers had the largest share of 47% of the total catch followed by *dol* netters (29%), purse seiners (11.9%), gill netters (11.3%), hooks and lines (0.3%) and non-mechanized boats landed 0.5%.

State of the fish stocks

The marine fishery in Maharashtra is facing crisis since late nineties owing to overfishing, urbanization, domestic and industrial pollution and habitat degradation. Among the commercially important resources Bombayduck, silver pomfret, elasmobranchs and lobster resources have declined significantly while vulnerable resources such as sand lobster (*Thenus orientalis*), Indian halibut (*Psettodes erumei*) and Karakara (*Pomadasys hasta*) have almost disappeared and thread fin (*Rawas* and *Dhara*) and jew fish (*Ghol*) are facing severe depletion. Although landings of penaeid prawns increased in late 1990s due to extension of trawling grounds to 90 m depth, the species composition has changed; small sized, low value species of *Solenocera* and *Metapeneopsis* are dominating the prawn landings in recent years which fetch much lower returns to the fishers.

The assessment of stocks of marine fishery resources in Maharashtra using 3 different approaches shows that:

- Decadal compounded annual growth rate (CAGR) of marine fish landings despite increasing annual growth rate of 3.2% from 1961 to 1990 slowed down to 0.41% during 1991-2000 and recorded negative growth rate (-4.7%) during past decade (2001-2010). The contribution of the state to total marine fish landings of India also declined from 19.6% in 1971-80 to 12.6% during 2001-10 and its rank in the total fish production slipped from 2nd to 5th in the country in 2012.
- Rapid assessment of 25 stocks in Maharashtra showed that barely 8% were abundant, 28% less abundant, 56% declining, 4% depleted and 4% in collapsed state.
- Length based stock assessment of 36 species of commercially important finfishes, elasmobranchs, crustaceans and cephalopods by analytical methods showed that 60% of the stocks are over-exploited.

Perceptions of fishing community

At individual and also at community level the total fish landing or production jargon is perplexing and largely incomprehensible to fishers. They understand catch and the money earned per day or per trip by the individuals. The fishers' perception is that the catch rates of important fishery resources have declined considerably which has largely affected the traditional fishers.

Generally, traditional fishermen attribute dwindling catches to newly introduced fishing methods, largely due to catching efficiency and quantum of catch. Although mechanization of traditional fishing crafts in the state commenced in 1960s, it was largely for propelling the crafts (largely motorization) that enabled speedy transport of the catch rather than operation of the bag nets and gill nets which are passive gears targeting mainly pelagic resources. Introduction of trawl nets in the same period was initially resisted but later acknowledged by the traditional fishing sector primarily due to absence of appropriate gear targeting demersal resources in general and prawns in particular. Moreover, the mechanized trawlers did not compete for the fishing area as well as the resources caught by the traditional fishing gears. On the other hand, purse seine fishing targeted overwhelmingly large volume of the pelagic fishes (1.5-2 t/trip) as compared to the catch of traditional gill nets and '*rampani*' nets. Besides, bulk landings by the purse seiner caused glut at the landing centres, crashing the prices and affecting the profitability of traditionally operated non-mechanized gill net and '*rampani*' net. The purse seiners invariably encroach the productive nearshore fishing grounds, which are largely reserved for the traditional fishing operations.

Off late, oil and natural gas exploration surveys and non-fishing zones around the oil wells in the traditional '*dol*' and gill net areas have been creating discontent among the fishers of northern Thane district. The fishing area of about 2000 sq km shelf area off Thane district is prohibited for fishing.

Impact of mechanized fishing

In Maharashtra, until early 1980s fishing by traditional '*dol*' nets, gill nets, '*rampani*' and hooks and line dominated the landings, but intensive shrimp trawling with multi-day fishing, introduction of purse seines in the late eighties enhanced the overall fishing effort by more than three folds. Such excessive increase in fishing effort has led to over-exploitation of the resources, as a result catch rates of most of the commercially important resources have declined. Besides, rising fuel costs, early cessation (shortening) of fishing season, reduced availability of quality fishes and subsequent declining profitability and

sometimes loss are the issues of the crisis. A study (Anon, 2012) carried out in the state showed that mechanized fishing in general and trawling and purse seining in particular, has indeed impacted the non-mechanized fishing adversely. The study also showed that although trawling did not compete with the traditional fishing for the fish resources, the impact was more significant than purse seines.

Traditional practices for regulation

Prior to mechanization, fishing in the state had two distinct phases, an intense fishing phase immediately following monsoon which used to last for 4-5 months, and after 1-2 months of lull during February-March, a second phase in pre-monsoon period during April-May. In monsoon there is complete cessation of fishing from June to end of August for nearly 3 months. The coastal population including fishers refrain from eating fish in monsoon, particularly in holy month of '*Sravana*' in Hindu calendar that occurs in monsoon. Such abstinence from eating fish in monsoon may have roots in conservation.

Along the northwest coast, as winter sets in by December the abundance of fish declines in February-March; the fishing becomes uneconomical and most of the fishers reduce fishing intensity in these months. Oceanographic studies along northwest coast (Banse, 1968) have shown that February-March is a transitional period when coastal currents reverse their flow from northwardly to southwardly direction. Between the reversals of currents, the shelf water is almost calm with very weak flow, as a result bag net operations which entirely depend on the force of tidal currents, cannot be sustained. The weak flow of water with tranquil condition gives generous opportunity for the young and newly hatched larvae of silver pomfret and Bombay duck to feed on zooplankton and epiplanktonic *Acetes*. In fact, these two fishes which have very poor swimming abilities and move only with the tidal oscillations, have attuned their life cycle to the season, so that they spawn intensively during December-February and their larvae hatch thereafter to get ample opportunity to feed during inter-reversal period. Such linking of life cycle the species to the natural oceanographic cycles, like seasonal cycles, ensure that the larvae are not carried away by the currents and their survival is maximized.

In the period of lull during February-March, Hindu fishermen observe festival of '*Holi*' while Christians have fast until '*Good Friday*' during which fishing is suspended for religious purpose for about one month. The traditional practice in this period is to have respite from the arduous fishing at sea and enjoy religious fervour and engage in less hectic repairing, mending and tanning of cotton and hemp fishing nets to get them ready for the next phase of fishing. Such linking of festivals with the seasonal changes in the sea that ensured conservation of the resources cannot be coincidental, but wisdom of ancestors for management and conservation.

Mitigation measures

On account of falling catch rates, increasing cost of fishing owing to rising fuel prices, shortening of fishing season, reduction in profit and sometimes loss, leading to laying off fishing has created crisis in the marine fisheries in Maharashtra. Therefore, reduction of fishing pressure on the fish stocks by observing closed fishing in certain seasons is advised as mitigation measure. This suggestion is welcomed by the fishing

community leaders and the state. Since southwest monsoon experiences inclement weather conditions from June to September, implementation of fishing ban during monsoon (60-65 days) has been welcomed by most of the fishers in the state. However, this ban is not uniformly observed in the neighbouring states as a result trawlers and purse seiners from southern states with shorter ban (45 days) encroached in the State's territorial waters and plundered fish resources, leaving the Maharashtra fishers in a helpless situation. Therefore, fishers in the state have been demanding uniform ban period all along the west coast. Within the state also, traditional fishers find that many trawlers and purse seiners continue fishing beyond 10th June and commence fishing well before the opening date, as a result they are deprived of fish when the ban is lifted. Reduction of trawling effort and strict compliance with marine fisheries act (MFRA, 1981) for the operation of purse seines are suggested by CMFRI for the sustenance of the traditional fisheries. But, economics of fishing operations have been overriding as a result multi-day trawling and purse seining is operational only when it is profitable, and cutting down fishing effort during unproductive idling period.

Incursions by trawlers in 'dol' net grounds for Bombayduck and targeting of silver pomfrets by modified 'Karli dol' netters in the nursery areas have created conflicts amongst trawlers, 'dol' netters and gill netters in the northern districts, while similar conflict was noticed for mackerel amongst 'rampani', purse seine and trawler operators in Ratnagiri and Sindhudurg districts. Since Bombayduck and silver pomfret are the economic strength of traditional 'dol' net and gill net fisheries, it is suggested by CMFRI to observe closure of 'dol' net fishing during February-March in the sea off Vasai-Arnala. This suggestion has also been taken up by the *Maharashtra Macchimar Kruti Samiti* in a positive note and in the past four years the fishermen have been closing the fishing season much before May. The early closer of 'dol' net fishing was rewarded with good catch of silver pomfret immediately after opening of the fishing season in September.

Although oil wells and natural gas explorations in the productive shelf (Bombay High) off Thane district spread over about 2000 sq km fishing area which is forbidden for fishing for security reasons, is in disguise acting as a recluse and serving as marine protected area (MPA) for many demersal fishes in general and silver pomfret and *ghol* in particular.

The fishing operations by multi-day trawlers, purse seiners and large gill netters have been far extended in the sea up to 100 m depth zone (20-50 nautical miles), while jurisdiction of Maharashtra Marine Fisheries Act (1981) is limited within territorial waters up to 12 nautical miles. Regulation and conservation of marine fisheries resources under this act is becoming increasingly difficult, therefore fishers are hoping for the state to bring amendments to the law or new bill for the Act that will be applicable to Exclusive Economic Zone (200 nautical miles) of the country and maritime states would be able to manage their resources.

Biotechnological approaches in Fishery Management

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There had been tremendous advances in molecular technology, genomics and biotechnology over the last few decades and the scope of its application in fishery resource management and aquaculture is enormous. The oceans bestow immense resources for research and development and these needs to be conserved for long term sustainability. Fish is the major source of protein for over a billion people, and biotechnology offers a 'give and take management system' whereby biotechnological tools can be used for conservation of ocean resources as well as for sustainable exploitation and utilization of the resources. Responsible fishery management aims to bring about sustainability by adopting an ecosystem approach to fisheries. Biotechnological tools can be effectively utilized to bring about sustainability of the marine ecosystems in many different ways. Again, aquaculture contributes about 41% of the total fish production, (63.6 million tonnes of fish and shellfish annually, FAO, 2012), and is the world's fastest growing food production sector, technological challenge in the aquaculture production and sustainability could also be met through biotechnological innovations.

Marine fish stock assessment

Information about the stock structure of fish populations is very important in devising management strategies which will ensure responsible management of the fishery. Fish stocks are spatially or temporally discrete units which may have different biological characteristics. So if different stocks exist within a particular species, those stocks have to be managed separately. Stocks can also be assessed separately for their sustainability and based on this, sustainable fishing strategies can be devised. If a stock is overexploited, fishing or harvesting can be regulated for that particular stock. There are several methods by which stock structure studies could be carried out. Conventional methods rely on the morphology of fishes and this may be cumbersome and inaccurate. Molecular tools provide a fast and efficient method of stock discrimination.

DNA markers of various types are being used for discerning genetic stock structure of fishes. Mitochondrial genes like cytochrome c oxidase, cytochrome b, control region (D-loop), ATPase 6/8 etc have been widely used for stock structure estimates. Mitochondrial

genome is circular and double stranded and is maternally inherited. This reduces the effective population size for mitochondrial DNA and this reduced effective population size results in greater genetic differentiation between isolated gene pools which makes it an attractive marker for studying population specificity. It is present in several copies depending on cell type and so a small amount of tissue is needed for its effective amplification. Nuclear DNA markers like Random Amplified Polymorphic DNA and microsatellite and minisatellite DNA have also been successfully used for such studies. Nuclear DNA markers help more accurate delineation of stock structure as it is developed from genomic DNA. RAPD (Random Amplified Polymorphic DNA) markers are dominant markers and the analysis can be completed in a relatively short time. It does not need prior information about the genome of the organism and the protocol is also simple. Since these are dominant markers, the information that can be generated using RAPD markers is very less and this is a serious limitation of the RAPD technique. Microsatellite DNA markers are the most popular for studying genetic stock structure and genetic differentiation. They are repeated DNA sequences having lengths of 1-6 base pairs which are tandemly repeated several times at each locus. Microsatellites are co-dominant in nature and they are inherited in Mendelian fashion. Microsatellites provide information about the effective number of alleles at each locus. Simple sequence repeats or microsatellites have high evolvability which makes them ideal for identifying variations at the level of stocks. Since microsatellite loci are non-coding, the variations are independent of natural selection.

Molecular taxonomy & DNA Barcoding

Documenting the rich biodiversity of tropical seas ensures effective conservation of the natural resources. This information is also very much useful for assessing the community structure and spatio-temporal variations in species distribution. Some of the species may be threatened/endangered which needs to be catalogued accurately. Molecular tools can be used for accurate and effective identification of the species and beyond, including strains, stocks or hybrids.

DNA barcoding using a short sequence of the organism's gene, usually mitochondrial cytochrome c oxidase gene (Hebert et al. 2003) is the most widely practiced method for easy and accurate identification. It often serves as a supporting tool to conventional taxonomy. The Barcode of Life Data System (BoLD) provides an online interface which allows scientists and researchers to work together and share their sequences. Several bar coding projects are being carried out around the world which have already contributed several thousands of barcodes of commercially important fishes. CMFRI has generated partial DNA sequences of cytochrome c oxidase and control region of fin fishes like tunas, sardines, whale sharks, mackerel and shell fishes like oysters, mussels and cuttle fishes. CMFRI has also developed a sex determination technique among marine mammals based on genomic DNA extracted from skin tissues. In addition to accurate identification and molecular taxonomy, DNA barcodes also helps to diagnose the presence of invasive species and their spread in the ecosystem. This will help in efficient quarantine and eradication efforts. Identifying predator – prey interactions by tracking prey species, knowing the presence of pest or pathogen species present in the ecosystem, development of species specific markers and a number of other related research works could be initiated by

using DNA barcodes. Species specific markers developed using barcodes can be used as a tool to detect the presence of eggs and larvae of the species. In the mariculture of mussels it is very important to know the timing and location of spat fall. Molecular markers could be effectively used in the forecasting of spat fall, by subjecting a plankton sample from the area of interest to species specific PCR. Species specific identification of larval stages of fishes which contribute to fishery can also be done using DNA based techniques.

Aquaculture biotechnology

Responsible fishery management can only be ensured by supplementing the marine fish production with aquaculture activities. Climate change and overfishing is causing uncertainties in the marine fishery scenario and aqua farming can be one of the viable alternatives. Aquaculture activities also should be sustainable and should not disturb the delicate balance of the ecosystem.

Improving the production performance of aquaculture systems can only be ensured by using superior germplasm. Application of biotechnology is emerging as a novel approach to augment aquaculture production wherein the whole spectrum of aquaculture, right from reproduction, larval rearing, nutrition, bioremediation, health management, to post harvest processing and bioprospecting is benefited. In the early days of carp farming, we have witnessed the control of reproductive cycles through hormone therapy and induced breeding, which revolutionized the Indian carp farming sector. Later on, the nineties witnessed the growth of the Indian shrimp farming industry, which during the last two decades has recorded both successes and failures. Biotechnological innovations and interventions in the areas of induced breeding, larval and growout feeds, DNA-based disease diagnosis and genetic improvement have helped the shrimp farming sector to tide over the adverse phases, thereby taking the industry forward.

Quantitative genetic tools can be effectively used for improving the quality of germplasm. Selective breeding by employing quantitative genetic principles has been employed to produce better brood stock of many commercially important fishes. Knowledge regarding heritability of the trait under consideration, phenotypic and genotypic correlations, heterosis and genotype-environment interactions is essential to plan a proper selective breeding strategy. Improved strains of *Artemia franciscana* have been produced with altered naupliar size in CMFRI using principles of quantitative genetics. Genetic improvement of freshwater carps has already been demonstrated, while similar programmes in brackishwater and marine aquaculture have to gain momentum in India.

Inbreeding and cross breeding strategies have also been used for the improvement of crops and livestock in India. Inbreeding is often applied along with cross breeding to produce superior offspring with hybrid vigor. Many combinations of inbreeding and cross breeding trials have to be conducted for the production of an offspring with hybrid vigor.

Chromosomal engineering is another alternative for the production of superior quality individuals showing higher growth and reproduction. Androgenesis, gynogenesis and ploidy manipulation have been practiced in aquaculture for production of individuals with higher growth and vigor. Androgenesis involves manipulation of reproductive process in such a way that only paternal genetic material is inherited. It will be helpful to produce viable YY supermales in the case of male heterogametic species and it has been successfully

applied to produce YY supermales in cyprinids, cichlids and salmonids. Gynogenesis is opposite of androgenesis where only maternal genetic material is inherited into the progenies and thus all female populations of fishes are produced. Androgenesis and gynogenesis is helpful in fishes where males or females alone show superior growth rate and performance.

Ploidy manipulation techniques like induction of triploidy or tetraploidy have also been used mainly in shellfishes for better growth. CMFRI has successfully induced triploidy in edible oyster, *Crassostrea madrasensis*. Triploidy had also been induced in *C. gigas*, *C. virginica*, *Saccostrea glomerata* and *Ostrea edulis*.

Hormonal manipulation of sex and reproduction offer another viable alternative to the production of all male or all female populations. Synthetically produced analogues of hormones are being used for hormonal manipulation. In the classical induced breeding technique for freshwater carps, introduction of hormonal extract containing GnRH (the key regulator and trigger of reproductive cascade in all vertebrates) was done to induce the spawning in carps, and later these were replaced by synthetic hormones such as Ovaprim.

Cryopreservation of gametes and embryos in the cold environment is another biotechnological intervention for improving aquaculture processes. Cryopreservation ensures year round supply of fish gametes which can be efficiently utilized for controlled reproduction. This will avoid increased dependence on wild collected seeds. Some of the important candidate species of fishes like seabass and grouper are sequential hermaphrodites (seabass-protandrous; groupers-protogynous) and so it is difficult to get males or females from the wild for controlled hatchery production. In fishes, sperm cryopreservation is widely practiced whereas cryopreservation of ova and embryos is yet to be perfected due to some inherent disadvantages of fish eggs and embryo.

Genetic engineering tools can also be employed for the production of superior genetic stock. Transgenic fishes can be produced using genetic engineering methods for the production of fishes with faster growth, disease resistance and improved environmental tolerance. The gene of interest like antifreeze protein genes, growth hormone genes or fluorescent protein genes can be incorporated into the genome of the desired species of fish which will get expressed in the progeny. In India, preliminary success has been reported in developing gene transfer technology in zebra fish, medaka and Indian catfish. Genetically modified zebra fish (Glofish) which glow in the aquarium, modified to produce fluorescent pigments red, green and yellow has been very popular and is widely used as a household aquarium pet.

Marker assisted selection (MAS)

Marker assisted selection (MAS) is a selection process by which prospective breeders are chosen based on genotypes using molecular markers. Diverse types of molecular markers like allozymes, mitochondrial DNA, RFLP, RAPD, AFLP, microsatellite, SNPs and ESTs are being used for marker assisted selection programmes. Identification of genetic relatedness, genetic diversity, pedigree determination, molecular tagging, tracking family and population lines and strain identification are the potential application of markers. It also envisages identifying markers linked to quantitative trait loci or QTL.

Feed biotechnology and nutrition

Feed biotechnology and nutrition of cultured fishes is one of the most essential aspects of any aquaculture venture and fruitful biotechnological interventions can be made in nutritional research so as to improve the performance of candidate fishes. Enzymes can be incorporated into feeds so as to increase the availability of nutrients in formulated feeds. These enzymes should be able to withstand variations in physico-chemical parameters like increased temperature conditions and they also should have a long shelf life. Phytase is one such enzyme which can be incorporated into feeds which will help in breaking down indigestible phytic acid in plant based nutrient sources and thus it will help in the release of digestible phosphorous.

Incorporation of probiotic bacteria into formulated feeds is another application of feed biotechnology to improve the disease resistance in cultured fishes. Probiotics are live microorganisms which when incorporated into diets confer some kind of a health benefit on the host. It is based on the principle of competitive exclusion where they exclude pathogenic bacteria competitively. These bacteria also release enzymes which will help in the digestion of food. The common organisms in probiotic products are *Aspergillus oryzae*, *Lactobacillus acidophilus*, *L. bulgaricus*, *L. planetarium*, *Bifidobacterium bifidum* and *Saccharomyces cerevisiae*.

Prebiotics are feed for probiotic organisms and they are resistant to attack by endogenous enzymes and consequently they allow the proliferation of gut microflora. Prebiotics can withstand high pelletizing temperatures in the feed and have a long shelf life. Supplementing dietary amino acids using genetically enhanced microorganisms have also been tried to increase the quality of feed. Essential amino acids like lysine and methionine have also been incorporated into feed as such to improve feed quality. Recent innovations in feed biotechnology include incorporation of nucleotides into feed as feed additives and thereby increasing the expression of some desired traits like growth or disease resistance. Nutrigenomics involves the application of functional genomics principles into nutrition research whereby the influence of nutrients on an organism can be studied at molecular levels.

Fish Health

Sustainability and economic viability of aquaculture ventures could only be ensured if adequate health management measures are taken at the right time. Disease diagnosis using conventional methods is time consuming and its specificity, sensitivity and speed is very limited. Disease diagnosis using biotechnological tools is accurate and efficient and valuable decisions could be taken at an appropriate time for devising optimal management strategies. Finfish and shellfish aquaculture is affected by a number of viral, bacterial and fungal diseases. White spot viral disease of the shrimp *P. monodon* has been a major threat to shrimp aquaculture and research institutions like CMFRI and CIBA have developed kits for the early detection of white spot virus which was a boon to aquafarmers.

Administration of DNA vaccines is another kind of biotechnological intervention that can be made in disease prevention and management. DNA vaccines are made from the DNA of the infectious organism and this can be introduced into the host DNA so that it gets expressed.

Pathogenic bacterial infections can be treated using phage therapy wherein lytic bacteriophages are used. A phage virus is used to infect and kill the bacteria and the phage should not interact with the surrounding tissue or with other harmless bacteria. Since the virus replicates quickly, a single, small dose is sufficient. Research related to the use of lytic bacteriophages for the treatment of *Vibrio* related infections are underway at Mangalore Fisheries College, National centre for aquatic animal health (NCAAH), Cochin and CIBA, Chennai.

RNA interference (RNAi) is a kind of RNA-guided regulation of gene expression in eukaryotic cells. Short chains of double stranded ribonucleic acid (dsRNA) present in the cell will interfere with the expression of genes having sequences complementary to this dsRNA. RNA interference is a kind of post transcriptional silencing of genes where dsRNA binds to specific mRNA and induce degradation of the homologous endogenous transcript, which causes reduction or loss of gene activity. RNAi is a promising tool for the management of viral diseases.

Genetically modified organisms with altered genetic material can be produced using recombinant DNA technology. Research efforts are being carried out to produce transgenic fishes with disease resistance.

Marine Bioprospecting

Marine bio prospecting is an emerging area where new sources of chemical compounds, genes, micro-organisms and other valuable products are explored from the sea. Biotechnological tools can be used in a sustainable way for making use of these biological resources and it also can be applied for the socio-economic development of the local communities. Marine organisms are potential sources of pharamaceuticals, enzymes, cryoprotectants, cosmaceuticals, and neutraceuticals. Novel drugs can also be extracted from marine organisms which may offer a substitute to antibiotics. Anti-inflammatory agents and anti-cancer agents can also be extracted from the secondary metabolites of marine bacteria and invertebrates.

Contributions of CMFRI to marine biotechnological research

Application of biotechnology in fisheries and aquaculture in India is in its developmental phase, and CMFRI has been the pioneer in many areas of marine biotechnological applications. Biotechnological innovations have left its footprint in many of the recent success by CMFRI - in the breeding of Cobia and silver pompano, hatchery rearing of clown fishes, development of the 'Varna' range of formulated feeds for ornamentals and in the development and commercialization of nutraceuticals from green mussel and seaweeds. Various other areas related to aquaculture such as value added products, novel processing methods and food safety are also benefitted by novel biotechnological methods.

The major contributions of CMFRI include;

- Selective breeding of native *Artemia* strains and production of a strain with altered naupliar size
- Production of triploid oysters
- Use of molecular taxonomical tools for stock structure studies of Indian oil sardine, Indian mackerel, threadfin breams, Bombay duck, groupers, clown fishes and sergeant major.

- DNA bar coding of several species of marine mammals, tunas, cuttlefishes, bombay duck and shrimps
- Technology for *in-vitro* pearl production
- Development of molecular diagnostic tools for white spot virus and *monodon* baculo virus (MBV)
- Production of low cost feeds for crabs and ornamental fishes
- Use of enzymes as feed additives
- Development of probiotics
- Neutraceuticals from Green mussel and Green algae

Conclusion

India is endowed with a coast line of about 7500 kms, an Exclusive Economic Zone (EEZ) of about 2 million sq. kms and vast brackishwater water resources of about 1.9 million ha, offering great opportunities to harness these aquatic resources using the science of aquaculture biotechnology. Biotechnology being a multidisciplinary system, requires the integration of scientific advances in biology, chemical sciences, material sciences and engineering. Aquaculture Biotechnology is an emerging and evolving area where marine resources are utilized for the development of novel applications, products and quality foods for the benefit of mankind. In India, aquaculture biotechnology is in its initial phase of development, and a concerted effort involving players from both Government and Private sectors under an umbrella or network of Aquaculture Biotechnology could bringout meaningful outcomes in the areas of food production, value added products, creation of employment and providing alternative livelihood.

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Nutritional Significance of Fish and Food Safety Issues

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Fish plays a major role in human nutrition. Importance of fish as a source of high quality, balanced and easily digestible protein is now well understood. Besides, it is also a well-known source of several other nutrients and is being accepted as a healthy food. A health food should contain all the essential constituents viz., carbohydrates, proteins, fats and minerals and vitamins in correct proportion. In this modern era of health conscientious people often presence of one component or other like cholesterol is not appreciated in the diet. In this context, fish assumes significance and fish caters the needs of the consumer besides contributing to significantly to nutrition. No doubt the per capita consumption of fish is increasing considerably world over.

Fish are highly heterogeneous group with over 25000 species. Fish are available from marine, freshwater and brackish water environments. The composition of fish living in marine environment is different in certain aspects from that of freshwater and brackish water environments. The water conditions like temperature salinity, pressure, seasonality and feeding habits contribute to the changes in the composition. Within the species the changes in composition are noticed depending on the season.

Composition

Like any other meat, water, protein, lipid and ash (mainly minerals) constitute the four basic constituents of fish meat (Table 1 & 2). The quantity of different constituents of meat viz. water, protein, fat and minerals represents the composition of meat. The composition depends on the type and species of fish. The variation in the chemical composition of fish is closely related to feed intake, migratory swimming and sexual changes in connection with spawning.

Table 1: Proximate composition of edible portion fish

Moisture	:	65-90%
Protein	:	16-21%
Lipid	:	0.2-25%
Ash	:	0.5-5.0%

Carbohydrates, vitamins, nucleotides and other non-protein nitrogenous constituents are present in minor quantities even though some of them are playing a vital role in maintaining the system and thus essential for growth and development of the organism.

Table 2: Typical compositions of selected fish, g/100g

Type of Seafood (raw)	Water	Protein	Lipid	Ash	Energy kcal
Common carp	74.84	20.84	3.15	1.17	111.71
Pearl spot	75.30	22.50	2.40	0.90	111.6
Milk fish	70.90	23.50	3.60	1.40	126.4
Mackerel	71.19	21.21	7.51	1.33	152.43
Oil sardine	67.01	19.38	11.70	1.73	182.82
Tuna	74.30	18.90	4.50	1.30	116.1
Cuttle fish	73.10	20.10	0.35	0.51	83.55
Freshwater prawn	78.29	21.17	0.27	0.37	87.11

Source: Biochemical composition of fish & shellfish, P.G. Viswanathan Nair, CIFT Advisory Series, 2000.

Water

Water is the most abundant substance in living systems, making up 70% or more of the weight of most organisms. Water pervades all portions of every cell and is the medium in which the transport of nutrients, cytoplasmic reactions for the maintenance of cells and the transfer of chemical energy occur. All aspects of cell structure and function are adapted to the physical and chemical properties of water. The water molecule and its ionization products, H^+ and OH^- , profoundly influence the structure and properties of all cellular components, including enzymes and other proteins, nucleic acids and lipids.

The proportion of water in fish varies widely between 65-90%, although it is normally in the range of 70-75%. There exists an inverse relationship between water and fat contents. Low water content is usually associated with relatively high fat content and vice versa. An example of a species with high water content is Bombay duck (*Harpodon nehereus*), with about 90% water in the flesh.

Protein

Proteins are perhaps the most important biomolecules and made up of amino acids, joined together by peptide bonds and have versatile role in the living system. Protein content of the fish muscle ranges between 16-21%. A protein content of below 15% signifies the food as low protein food. The protein content varies with the type of muscle and dark muscles usually contain low levels of moisture and protein compared to light muscle.

Proteins are complex molecules and are generally classified based on the shape, solubility and chemical structure. Based on the solubility in salt solutions, proteins are classified into three groups viz. sarcoplasmic proteins, myofibrillar protein and stroma. Sarcoplasmic proteins (albumin and globulin) are soluble in salt solutions of low ionic strength (<0.15 M). In fish meat this fraction constitutes 25-30 % of the protein. In comparison, mammalian meat contains about 35 – 40% sarcoplasmic proteins. Among fish, pelagic fish (sardines, mackerel etc.) have higher content of sarcoplasmic proteins while demersal fish (flat fishes, scienids etc.) have lower content. The sarcoplasmic proteins fraction contains the metabolic enzymes localized inside the cytoplasm or inside cell organelles like endoplasmic reticulum, mitochondria and lysosomes. As there is uniqueness associated with sarcoplasmic proteins from different species, the electrophoretic patterns of these fractions can be used for species identification.

The myofibrillar proteins (actin, myosin, tropomyosin and troponin) structural proteins, which constitute 65-70 % of the total protein (compared with 40 % in mammals). These proteins are soluble in neutral salt solutions of fairly high ionic strength (0.5 M). The structural proteins make up the contractile apparatus responsible for the muscle movement. The amino acid composition is approximately the same as for the corresponding proteins in mammalian muscle, although the physical properties may be slightly different. Changes in the environment alter the nature of these fish proteins. Treatment with high salt concentrations or heat may lead to denaturation, irreversibly changing the native protein. Some of these changes have beneficial effects in the processing of fish for product development. The rheological and functional properties of the fish proteins are associated with these proteins and play significant role in the preparation of surimi based products.

Connective tissue proteins (also called stroma proteins) constitute approximately 3 % of the protein in teleosts and about 10 % in elasmobranchs (compared with about 17 % in mammals). It is this low content of collagen that gives the soft texture to fish meat. Stroma proteins are insoluble in neutral salt solution or in dilute acids or alkalis. Collagen is the major connective tissue protein in fish and is very similar to that present in mammals. However, fish collagen is much more thermolabile and contains fewer but more labile cross-links than collagen from warm-blooded vertebrates. The hydroxyproline content is in general lower in fish than in other animals. Different fish species contain varying amounts of collagen in the body tissues and may be related to the swimming behaviour of the species. Further, the varying amounts and varying types of collagen in different fishes may indicate the differences in the textural properties of fish muscle.

Table 3: Essential Amino Acid content in various protein sources (g/100g)

Amino acid	Fish	Milk	Eggs	Beef
Lysine	8.8	8.1	6.8	9.3
Tryptophan	1.0	1.6	1.9	1.1
Histidine	2.0	2.6	2.2	3.8
Phenylalanine	3.9	5.3	5.4	4.5
Leucine	8.4	10.2	8.4	8.2
Isoleucine	6.0	7.2	7.1	5.2
Threonine	4.6	4.4	5.5	4.2
Methionine-cysteine	4.0	4.3	3.3	2.9
Valine	6.0	7.6	8.1	5.0

Source: Lahsen Ababouch, 2000. Fish Utilisation and Marketing Service

Fish proteins contain all the essential amino acids (not synthesized and need to be provided in the diet) in the required proportion and hence have a high nutritional value, which contribute to their high biological value. Cereal proteins are usually low in lysine and/or the sulphur-containing amino acids like methionine and cysteine, whereas fish protein is an excellent source of these amino acids. In diets based mainly on cereals, a supplement of fish can, therefore, raise the biological value significantly. The chemical score or amino acid score of fish protein (70) compares well with that of whole egg protein (69), which is considered a standard protein source, and slightly more than that of cow's milk (60). Similarly the protein efficiency ratio of fish proteins is 3.5 against that of egg protein (3.92), beef (2.3) and milk protein (2.5). Fish is also rich in a non-protein amino acid taurine which has a unique role in neurotransmission.

Lipids

Lipids are heterogeneous group of compounds extracted with solvents of low polarity. Glycerides, fatty acids, phosphoglycerides, sphingolipids, aliphatic alcohol and waxes, steroids and several lipoproteins are the important components belonging to this group. The terms fat or oil are often used to represent this group of compounds.

Lipid is the third major constituent, quantity wise, in fish muscle. Variation in the fat content is much wider than that of protein. Fat content varies between species as also within the species between different organs. Fish with fat content as low as 0.5% and as high as 18-20% are common. In many species there is a buildup of fat during feeding season and its proportion decreases substantially after spawning. As far as the type of lipid in fish muscle is concerned, triacyl glycerol and phosphoglycerides both containing long chain fatty acids

are the major component. Squalene and wax esters are other components found in unusually high concentrations in certain fish meat.

Some tropical fish also show a marked seasonal variation in fat content. West African shad (*Ethmalosa dorsalis*) shows a range in fat content of 2-7 % (wet weight) over the year with a maximum in July. Similarly the Indian sardines (*Sardinella longiceps*) show high variations in fat content and during seasons the content go up to 18%. Based on these variations in fat content, fish are broadly classed as lean (fish that store lipids only to a limited extent) and fatty fishes (fish storing lipids in fat cells distributed in the body tissues). Typical lean species are the bottom-dwelling ground fish like cod, saithe and hake. Fatty species include the pelagics like sardines, herring, mackerel and sprat. The main role of fat is as a source of stored energy. The storage sites for fat (fat depot) are different for different species. Liver, adipose tissues etc. are the common sites where fat is stored in fish. In a great majority of cases, the depot fat is mainly triglycerides. The white muscle of a typical lean fish (cod) contains less than 1 % lipids.

Lipids of fish and other aquatic animals contain high proportion of highly unsaturated long chain fatty acids (Table 3). Fatty acids with carbon chain varying from 10 to 22 and unsaturation varying from 0 – 6 double bonds are common. Among the saturated acids palmitic and stearic acids are the important ones and in the monounsaturated group, palmitoleic and oleic acids are the major constituents. Among the polyunsaturated acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the major components. The percentage of polyunsaturated fatty acids with four, five or six double bonds is slightly lower in the lipids from freshwater fish than in the lipids from marine fish. However, the composition of the lipids can vary with the feed intake and season and many other factors.

Table 4: Omega-3 Polyunsaturated fatty acids (g/100g edible portion) in Selected Fish and Shellfish

Type of Fish (raw)	Lipid Content	20:5 w-3	22:5 w-3	22:6 w-3	Total w-3
Oyster	1.3	0.2	tr	0.2	0.5
Squid	1.7	0.1	tr	0.3	0.5
Lobster	1.6	0.2	tr	0.1	0.3
Crab	5.5	0.5	0.1	0.5	1.2
Herring	13.2	0.8	0.1	1.0	2.0
Mackerel	16.1	0.7	0.1	1.1	2.0
Pilchard/Sardine	9.2	0.9	0.1	1.1	2.2
Tuna	4.6	0.3	0.1	1.1	1.6
Salmon	11.0	0.5	0.4	1.3	2.3

The biological significance of fish oils is mainly due to the presence of polyunsaturated fatty acids. In human nutrition fatty acids such as linoleic and linolenic acid and arachidonic acid are regarded as essential since they cannot be synthesized in the system. In marine fish, these fatty acids are present at a relatively low level. However, presence of other polyunsaturated fatty acids gives importance to fish oils compared to vegetable oils. These acids, eicosapentaenoic acid (C20:5 w3) and decosahexaenoic acid (22:6 w3) are reported to play important role in the development of nerve cells in growing children, besides having proven effects in atherosclerosis and as antithrombotic factor.

Fish oils have a positive cholesterol lowering effect by increasing the content of high density lipoprotein and lowering the LDL/HDL ratio. Evidences indicate the positive effect of PUFAs to reduce cardiac arrhythmias - the irregular electrical conductivity of heart muscle often leading to cardiac arrest. Presence of high levels of PUFA increases the membrane permeability and also has effect on blood pressure. Generally, approximately 50% of fatty acids in lean fish and 25% of fatty acids in fatty fish are PUFAs. Eicosapentaenoic acid (C20:5 w3) and decosahexaenoic acid

Table 5: Mineral Contents of Selected Fish and Shellfish

Type of Seafood	Sodium	Potassium	Calcium	Iron	Zinc	Iodine (mcg)	Selenium (mcg)
Cod	60	340	9	0.1	0.4	110	28
Herring	123	320	60	1.2	0.9	29	35
Mackerel	63	290	11	0.8	0.6	140	30
Pilchard/Sardine	120	360	84	1.4	1.0	29	34
Tuna	47	400	16	1.3	0.7	30	57
Mussel	290	320	38	5.8	2.5	140	51
Lobster(boiled)	330	260	62	0.8	2.5	100	130
Crab	420	250	n	1.6	5.5	n	17
Prawn	190	330	79	1.6	1.5	21	16

n= data not available

Source: : Holland, B., Brown, J., & Buss, D.H., 1993. Fish and Fish Products; the third supplement to McCance & Widdowson's The Composition of Foods (5th Edition), HMSO, London.

(22:6 w3) are the major PUFAs associated with fish oils. EPA and DHA are reported to reduce vasoconstrictor effect by competing with arachidonic acid which results in strong vasoconstriction through the formation of thromboxane A2, a strong vasoconstrictor. EPA are also reported to have antitumor effect through suppression of cell proliferation while DHA appears to induce apoptosis. Other clinical symptoms where PUFA plays key role include acute respiratory distress syndrome, multiple sclerosis. Alzheimer's diseases etc. In elasmobranchs, such as sharks, a significant quantity of the lipid is stored in the liver and may consist of high molecular weight hydrocarbon like squalene. Some sharks may have liver oils with a high concentration (80%) of the lipid as unsaponifiable substance, mostly in the form of squalene.

Minerals

Fish is good source of almost all the minerals present in seawater (Table 4) and the total mineral content in wet fish meat range from 0.6 to 1.5%. Calcium and phosphorus account for more than 75% of the mineral in the skeleton. Besides forming a part of skeleton, phosphorus has a number of metabolic and physiological roles in fish. Element of special nutritional significance, iodine and fluorides are also present in fish. The iodine content in marine fishes ranges from 0-300 µg per kg fish. Sulfur is present in the form of amino acids as fish is good source of sulfur containing amino acids, cysteine and methionine. Copper and iron are associated with muscle tissues. Cobalt is present in the form of cyanocobalamin (Vitamin B₁₂). It should be noted that the sodium content of fish meat is relatively low which makes it suitable for low-sodium diets. Certain fishes like tuna are especially good sources of macro minerals like magnesium and trace elements like selenium.

Vitamins

Both water soluble and fat-soluble vitamins are present in fish. The content of fat soluble vitamins varies between fish and within fish with season. The hepatic reserve of vitamin A in aquatic animals is much greater compared to mammals and birds. The meat of fatty or semi-fatty fishes is an excellent source of vitamin D, the concentration of which varies from 500 to 3000 IU/100g. In fish flesh vitamin E occurs largely as α -tocopherol. The antihaemorrhage factor, vitamin K is also present in fish.

Table 6: Vitamin Content of Selected Fish and Shellfish

Type of Seafood	Vitamin A, mcg	Vitamin D, mcg	Vitamin E, mg	Vitamin B1, mg	Vitamin B2, mg	Vitamin B6, mg	Vitamin B12, mcg
Cod	2	tr	0.44	0.04	0.05	0.18	1
Herring	44	19	0.76	0.01	0.26	0.44	13
Mackerel	45	5	0.43	0.14	0.29	0.41	8
Pilchard/Sardine	n	11	0.29	tr	0.22	0.39	11
Tuna	26	7.2	n	0.10	0.13	0.38	4
Mussel	n	tr	0.74	tr	0.35	0.08	19
Lobster(boiled)	tr	tr	1.47	0.08	0.05	0.08	3
Crab	tr	tr	n	0.07	0.86	0.16	tr
Prawn	tr	tr	2.85	0.04	0.12	0.05	7

tr=trace amounts only; n= data not available

Fish meat is a good source of the B vitamins. The red meat has higher content of vitamin B than white meat. Fish liver, eggs, milt and skin are good sources of B1, riboflavin, pyridoxine, folic acid, biotin, and B12. The amount of vitamins and minerals is species-specific and can vary with season. The vitamin content is comparable to that of mammals except in the case of the A and D vitamins, which are found in large amounts in the meat of fatty species and in abundance in the liver of species such as cod and halibut. Liver oils from shark (13300 IU/ g oil) and tuna are rich in vitamin A. Large quantity of vitamin E, varying between 500 – 3000 IU per 100 g, is present in liver and body oils.

Non Protein Nitrogenous compounds

The water-soluble, low molecular weight, nitrogen- containing compounds of non-protein nature constitute 9 to 18% of the total nitrogen in teleosts. The major components in this fraction are: volatile bases such as ammonia and trimethylamine oxide (TMAO), creatine, free amino acids, nucleotides and purine bases, and, in the case of cartilaginous fish, urea. The composition varies from species to species and within the species depending on size, season and muscle sample.

TMAO constitutes a characteristic and important part of the NPN-fraction in marine species but is virtually absent in freshwater species and other terrestrial organisms. The amount of TMAO in the muscle tissue depends on the species, season, fishing ground, etc. In general, the higher content of TMAO is found in elasmobranches and squid (75-250 mg N/100 g) while flatfish and pelagic fish have comparatively lower content.

Quantitatively, the main component of the NPN-fraction is creatine. In resting fish, most of the creatine is phosphorylated and supplies energy for muscular contraction. The NPN-fraction also contains a fair amount of free amino acids. Taurine, alanine, glycine and imidazole-containing amino acids seem to dominate in most fish. Of the imidazole-containing amino acids, histidine has attracted much attention because it can be decarboxylated microbiologically to histamine. Active, dark-fleshed species such as tuna and mackerel have a high content of histidine. The amount of nucleotides and nucleotide fragments in dead fish depends on the state of the fish.

The major and the minor constituents undergo changes during processing and storage and their interactions with each other results in the formation of chemicals in the body. Some of the metabolites, like histamine, hypoxanthine are used as quality indices to evaluate the quality of the fish.

Food safety issues

Food safety is a discipline dealing with producing, storing and transportation of food in order to prevent food borne illness. Food facilitates growth not only for human beings but also for microorganisms and animals as well. If you provide a conducive environment for bacteria to grow in food, it becomes contaminated causing inconvenience to the consumers.

In the global context, produced in one part of the world is available in the other part and if sufficient precaution is not taken this may lead to epidemic level. Therefore food safety is viewed as a serious matter and has been taken as a priority agenda at the highest body of Food and Agricultural Organization. Codex Alimentarius Commission (CDC) of the FAO is body formed in 1962 to tackle the issues related to trade and consumers. This transportation of commodities from one corner of the world to the other also leads to food security issues as a result of transportation of the microorganisms of concern to the destination country along with food. As of now the CDC has about 165 member countries representing over 98% of the world population. The primary objective of the organization is to provide guidelines for hazards related to foods, code of practices for production,

transportation and distribution, harmonize food standards between countries and to protect health of consumers and ensure fair practices in food trade.

There are two aspects which need to be considered when factors affect the consumers are concerned. One is food quality which addresses the quality of food meant for consumption which is related to the characteristics of food affecting the sense of the consumers. In the same food standards are related to safety and hygiene, quality, packaging, labeling and handling and storage. The second is concerned with safety aspects namely the consequence of consuming a food. The poor quality food need not be unsafe and vice-versa. The food safety standards are related to the presence of additives, environmental contaminants, agricultural chemicals, radioactivity and micro-organisms and their toxins. It is not only the presence of these contaminants but also their quantity that is crucial as far as safety is concerned.

Besides contributing to nutrition food also contribute to transmission of diseases. Though there are specific standards available for the preparation and transportation of standards, most often enough care is not taken leading to food safety issues. Water is one of the important agents which plays a major role in the transmission of food borne diseases. This highlights the importance of sanitation and hygiene in food producing establishments and WHO has given five key principles of food hygiene as follows:

1. Prevent contaminating food with pathogens spreading from people, pets, and pests.
2. Separate raw and cooked foods to prevent contaminating the cooked foods.
3. Cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens.
4. Store food at the proper temperature.
5. Do use safe water and cooked materials.

Hazard and safety concerns

Any biological, chemical or physical agent that is reasonably likely to cause illness or injury in the absence of its control is called a hazard. Hazards profile is food is so extensive that it is difficult to qualify and quantify majority of them. However, as per the guidelines from the organizations concerned quite a few are notified as important and need to be addressed if it is meant for human consumption. As has been discussed we are aware that there are three major classes of hazards viz., biological, chemical and physical which make food unsafe for human consumption. These hazards are introduced in to the food along the food value chain at any point starting from harvesting, processing, transporting, preparing, storing and serving.

Contamination by microbiological hazard occurs when food becomes contaminated by microorganisms at any of the stages mentioned above from air, water, soil, animals and the human body. The microorganisms are ecosystem specific. The consortia of microorganism associated with terrestrial ecosystem are different from that of water. Generally the microbes associated with unpolluted water system or marine environment are nonpathogenic. Same is the case when an animal is alive – no external microbes can act on them. But once the animal dies other microorganisms act on them which most often may be a pathogen from human point of view. This mainly happen during handling operations,

either at the preprocessing or processing area. Microorganisms commonly associated with foodborne illnesses include bacteria, viruses and parasites.

In the same way the chemical hazard profile for product depends on the source of the commodity. The product from a particular soil retains the characteristics of the soil from where they are harvested. The vegetable or a fish harvested from a particular ecosystem are likely to possess all the chemical contaminants, particularly pesticide residues, polychlorobiphenyls, dioxins, heavy metals etc. from that source. Besides, chemical hazards can occur at any point during the handling stages, including storage, preparation and service.

These organisms can affect human health causing infection, intoxication and even death. Infection is the consequence of invasion by organisms followed by multiplication in the body. When the toxin produced by the organism affect the human then the condition is called intoxication. Some of the disease causing microorganisms which are pathogenic human beings are bacteria (*Salmonella* spp., *Enterohaemorrhagic Escherichia coli*, *Campylobacter jejuni*, *Yersinia enterocolitica*, *Listeria monocytogenes*, *Bacillus anthracis*, *Bacillus cereus*, *Staphylococcus aureus*, *Clostridium botulinum*, *Clostridium perfringens*, *Vibrio vulnificus*, *Vibrio parahaemolyticus*), viruses (hepatitis A virus, Norwalk viruses, rotavirus) and Parasites (*Toxoplasma gondii*, *Cryptosporidia*, *Giardia* sp., *Trichinella spiralis*, *Taenia solium*, *Anisakis* spp)

There are a number of chemicals that are present in the ecosystem which enters the food it becomes a contaminant which ultimately a health hazard. Some of the contaminants are naturally present in the ecosystem such as heavy metals, some get in to ecosystem due to human involvement such as agricultural chemicals like pesticides and related compounds, industrial chemicals such as polychlorobiphenyls, dioxins etc., and some produced in the food due to spoilage during storage. The presence of residues in food may result from the application of a particular chemical during agricultural production, without the intention that the involved compound or its degradation products remain present in the agricultural commodity when it is transformed into food. In the same way lots of antibiotic residues which are used with purpose in animal husbandry activities get mixed up food and get exposed as food contaminant or hazard.

The chemicals formed in the food can be controlled by appropriate preservation techniques while the other two categories cannot be controlled by any means. Lots are chemicals are used in food industry intentionally or unintentionally. Intentionally added chemicals are used to enhance their shelf life or keeping quality or to improve the texture of the product. Some are permitted by law for use in food but most used are not permitted chemicals. In the same way intentionally added chemicals are mostly permitted additives. According to European Union's Directive 89/107/EEC, a food additive is defined as "any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in manufacture, processing, preparation, treatment, packaging, transport or storage of such food, results or may be

reasonably expected to result, in its or its by-product becoming directly or indirectly a component of such foods”.

But often they are used beyond the recommended level posing problem to the consumers. These types of misuse of chemicals in food lead to allergic responses among the consumers in the milder sense to fatality in specific cases. Chemicals provoking food intoxications can be classified in various manners as e.g. food additives, residues, contaminants and endogenous substances. Unintentional contaminants are related to the sanitizers used for keeping hygiene in the processing establishment, grease or paints used in different machineries or elsewhere.

Physical hazards usually encountered in foods as a result of unintentional or accidental contamination and poor food handling practices. These are contaminants which are not normally present in food but causes injury to the consumer due to its presence. These are generally from three different categories viz., mineral comprising of sand, stones, dust, metals, glass, fibre, etc., plant materials such as weeds, leaves, stems, etc. and animal materials such as mites, insects, rodents, etc. which are likely to pose problem to the consumer needs to be considered while performing hazard analysis.

What are the options?

Controlling the hazards is possible only if identify them correctly. In that context, hazard analysis becomes an important area of food safety regime. The good management practices (GMP) are the immediate solution. GHP are the general practices that are intended to reduce microbial food safety hazards that include sorting, packing, storage and transportation operations.

Food quality control is necessary to ensure that food related supplies are safe, of good quality and in adequate amounts in appropriate time at affordable price. The idea is to ensure acceptable nutrition and health status to world population. The international guidelines and the good Manufacturing practices, Certification under an Internationally Accepted Standard (ISO 9000 series), Total Quality Management (TQM) and ISO offer a meaningful solution to address these issues. A **good manufacturing practice (GMP)** is a production and testing practice that helps to ensure a quality product. GMP regulations require a quality approach to manufacturing, enabling food producing establishments to minimize or eliminate and legal aspects. Hazard Analysis Critical Control Point (HACCP) is a systematic, science instances of contamination which in turn protects the consumer from purchasing a safe product. Therefore GMP ensures that products meet the requirements in terms of quality, safety based programme which can be part of GMP on order to attain the requirements of food safety.

HACCP is an important component of GMP, which was first established in 1960 for NASA for space programme and is a systematic hazard control programme which focuses on hazard prevention rather than hazard control. It is a systematic process control system which identifies hazards and implements control measures to eliminate or reduce the hazard to acceptable level. The effective implementation of HACCP requires in place certain pre-requisite programmes which are nothing but operational conditions providing basis for the HACCP system. A appropriate HACCP programme should cover all the major steps in the product starting from raw materials to production to packaging to transport to

distribution. The important sanitary conditions which are critical to implementation of HACCP and hence to food safety management systems include safe water, condition and cleanliness of food contact surfaces, prevention of cross contamination, personal hygiene (hand washing, hand sanitizing etc.), control on additives and prevention of adulterants, labeling, storage & use of toxic compounds, employees health condition, and exclusion of pests

Therefore, the cold chain plays a significant role in modern global trade in all food commodities. Increasingly, market demand has heightened the importance of uncompromised food safety and quality as it travels through sectors that include farming, food processing transportation/distribution, retailing and ultimately as it ends up in the foodservice industry or on the consumer's table. Control of the storage temperature is vital in maintaining the quality and safety of refrigerated foods throughout the chain. As a consequence, it is important that good chill/storage procedures are in place to ensure that such foods not only achieve their required shelf lives but are safe for consumption by the end user.

Traceability and food safety

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Introduction

Food safety has been the topic of some recent policy changes and increased awareness among the public. These developments indicate that there is a need for a system that can identify hazards in food sufficiently early so that these can be tackled in time, before developing into real risks. Traceability is one of the management tools which can be developed and used to mitigate and prevent food safety hazards in a major way. There is an increasing demands for detailed information on the nature and origin of food products. Thus traceability is becoming a legal and commercial necessity.

There are several definitions for traceability. European Union (EU) defines traceability as the ability to trace and follow a food, feed, food-producing animal or substance intended to be or expected to be incorporated into a food or feed, through all stages of production, processing and distribution (Regulation EC No. 178/2002). ISO definition of traceability (ISO/DIS 12875) concerns the ability to trace the history, and for products this can include the origin of materials and parts, the processing history and the distribution and location of the product after delivery. Traceability includes not only the principal requirement to be able to physically trace the products through distribution chain, from origin to destination and vice versa, but also to be able to provide information on what they are made of and what has happened to them

USFDA defines traceability as the efficient and rapid tracking of physical product and traits from and to critical points of origin or destination in the food chain necessary to achieve specific food safety and, or, assurance goals. Additionally, labeling and traceability of genetically modified food (GMF) are important issues that are considered in trade and regulation, particularly by EU legislation (Regulation EC No. 1829 & 1831/2003). HACCP and Track & Trace (traceability) are closely connected aspects of Food Safety. While HACCP is usually seen as an internal matter in food companies, traceability - especially whole chain traceability - obviously spans the whole flow of the food supply chain and its components from “farm to fork”.

HACCP aims at preventing food from doing harm to consumers and assuring that it lives up to a consistent level of quality. Traceability aims at identifying and containing the damage, once food safety has been breached. However, in a more positive sense, traceability across the food chain can also play an important role in certifying the authenticity of a product and thus reduce the risk of counterfeiting and old meat being relabeled with new sell-by dates. Traceability is of absolute importance in proving any credence to claims for organic origin, etc. The same is the case with ISO 22005:2007, where it is mandatory for every food chain to develop and implement procedure for traceability as per Codex Alimentarius system. The system requires that any food producing industry should :

- Sets out the “general principles and basic requirements for system design and implementation” of traceability system
- Uses Codex definition of traceability
- Requires food/feed business to:
 - Set food safety, quality & other objectives
 - Design a system that meets regulatory & customer requirements
 - Specify the information to be obtained from its suppliers, collected within itself & provided to its customers
 - Establish procedures, documentation, etc
 - Implement the system (training, etc)
 - Monitor the system
 - Review it regularly & Update

The main objective of a traceability system is to record the history of a product. It has to take in account the history and safety of the raw materials used in the production and follows the process through the distribution to the consumer. Therefore, traceability system basically benefits to both producer and consumer. Traceability system enables fewer products to be recalled and brings important cost savings where the aim is to provide consumers with the high quality and safety products which are produced in a cost efficient way. Furthermore, benefits of an efficient traceability system provide feedback on product quality to the supply chain and improve consumer confidence. Currently, traceability systems can be incorporated into information systems where consumers can get information on any product such as via electronic data interchange/EDI.

The implementation of traceability has generated a significant amount of interest as there is no single system accepted globally. Therefore, it is important to distinguish between legal requirements and technologies required for providing a track and trace capability. The traceability system should enable efficient food safety management, but it is the responsibility of individual companies and supply chains to voluntarily take advantage of the capabilities it provides.

Basically any food traceability system should address the following criteria:

- What do products/ingredients/components consist of?
- Where did they come from?
- Where did they go?

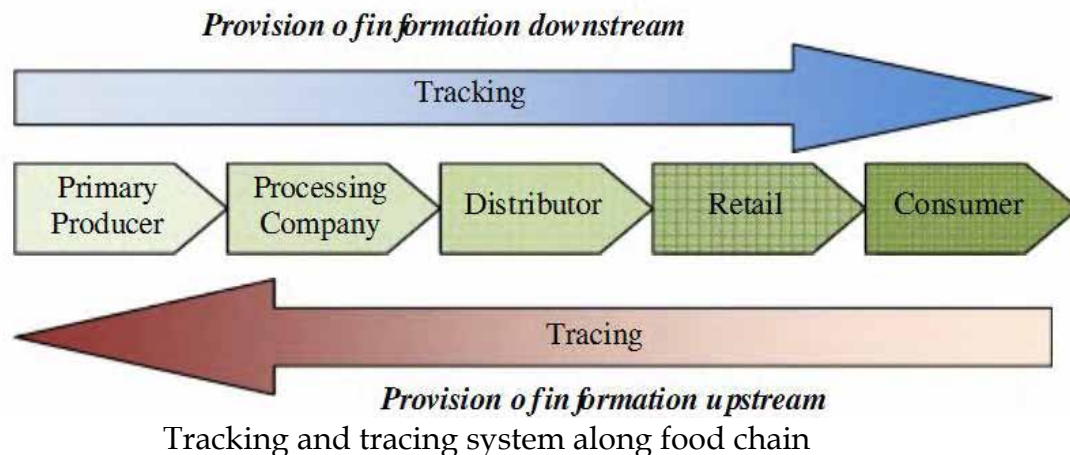
- □□Traceability of risks and actions based on HACCP principles:
- What risks and processing were the products/ingredients/components subjected to?
- Did general conditions live up to the requirements during processing?
- Could different products have affected (contaminated) each other?
- Were there any deviations from established procedures?
- What actions were taken to remedy every problem reported and discovered?
- What actions were taken to limit damage?
- What actions were taken to avoid future problems?

To deal with food safety in an optimum way, both aspects of traceability are essential and should be combined. Product traceability alone cannot identify a cause of a food incident, but it can help find out where to look, because it shows where components and ingredients came from. Traceability of risks will be able to identify the cause precisely and at the same time reveal whether other lots have been contaminated. And then, in turn, product traceability can locate these batches.

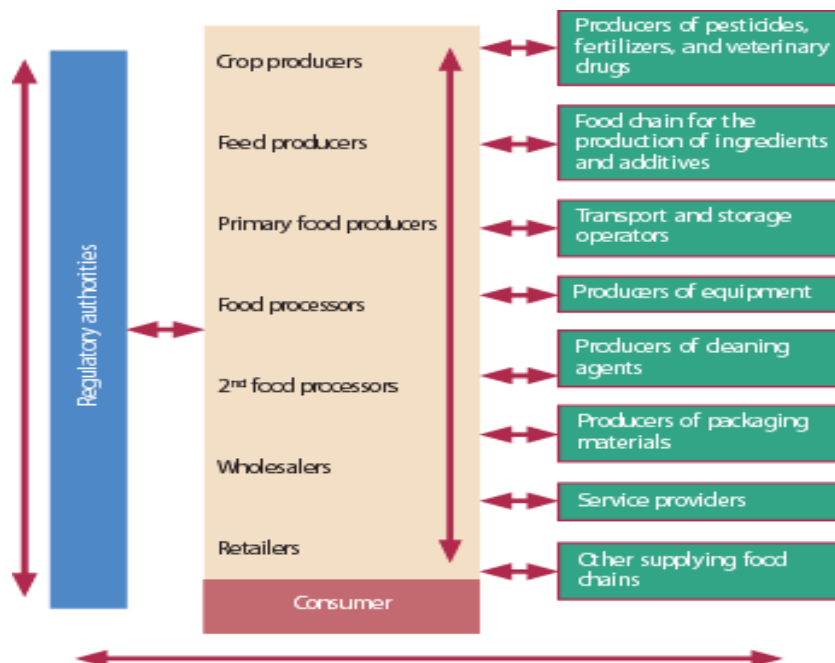
The implementation of food traceability

The EU's General Food Law entered into force in 2002 and makes traceability compulsory for all food and feed businesses. It requires that all food and feed operators implement special traceability systems. They must be able to identify where their products have come from and where they are going and to rapidly provide this information to the competent authorities. It is mandatory that all food and feed business operators to establish traceability systems, even when their customers do not require it. Traceability is also mandatory for beef in Japan, while exported beef in Australia, Argentina and Brazil is obliged to be traceable. Conversely, up to date traceability is voluntary in the U.S. In order to be able to trace products and retrieve related information, producers have to provide information and keep track of products during all stages of production, including primary production, processing, distribution, retailing, and consumer. Furthermore, traceability requires a verifiable method to identify growers, fields and produce in all its packaging and transport/storage activities at all stages of the supply chain.

Basically, there are two important aspects regarding the implementation of traceability, which are tracking and tracing system. Product tracking is the capability to follow the path of a specified unit of a product through the supply chain, whereas product tracing is the capability to identify the origin of a particular unit and/or batch of product located within the supply chain by reference to records held upstream in the supply chain. The implementation and maintenance of the traceability regulations require an effective and efficient system to track and trace back the products. Consequently, methodologies for the analyses of the food materials combined with information technology systems are essential to establish a working tracking and tracing system .



By the new EU regulation of traceability, the food processor is obliged to ensure that the food products meet the requirements of food law in which previously it was sufficient for a processor to be able to identify the source of an ingredient. This implies that the source of all materials involved can be traced and a processor must therefore be able to prove that his suppliers can provide full traceability. If any problem is suspected, tracking must go as far as the consumer. Traceability covers everything that happens to the products before, during and after the manufacturing, packaging, and distribution.



Tracking application for traceability

A product traceability system requires the identification of all the physical properties from which the product originates, including the location where it is originated, processed, packaged, and stocked. In order to keep track of items within a food supply chain it is crucial to identify items in each step of the chain. This application is done by data loggers as mark or tag that follows the item and can be read further down the supply chain. Data loggers / carriers carry an identifier which is a character based or alphanumeric code. There are 2 types of information are comprised within data carrier, i.e. primary and secondary information regarding the identification. Primary identification is used to determine the identification of a unit, by recognizing a set of features that can be considered characteristically unique for the concerned unit. The identification method can be DNA or other molecular based analytical methods. Secondary identification is an identifier to a unit, in a form that can be attached to a unit through or partly through the supply chain. The identifier can be thought of as a code, often as a number or an alpha-numeric string.

GS1 (formerly EAN/UCC) is universally accepted as an identification and communication system. The system consists of three components: (1) Identification numbers; used to identify a product (Global Trade Item Number-GTIN), location (Global Location Number-GLN), logistic unit (Serial Shipping Container Number-SSCC), service or asset (Global Returnable Asset Identifier-GRAI); (2) Data carriers; the barcodes or radio frequency tags used to represent these numbers. The data carriers vary according to the level of information required or the space available; and (3) Electronic messages; the means of connecting the physical flow of goods with the electronic flow of information. These technologies have been used in meat traceability, providing a robust tracking system for most elements of the meat chain.

Considerations on implementing traceability system

An efficient and effective system of traceability can significantly reduce operating costs as well as increase productivity. At the same time, such a system provides product safety elements and thus makes consumers safer. In order to establish product traceability system, particularly on food traceability system, there are 4 fundamental concepts must be taken in account. Accordingly, those aspects are product identification, data to trace, product routing, and traceability tools. The implementation of traceability system, thereby, should consider to the concerned product properties.

In practice, different technical approaches can be used for tracking system. The data accuracy and reliability required can guide the selection of the traceability tool. Accordingly, cost is a relevant factor and so must also be taken into account. Final choice must consider the degree of compatibility with the product and the production process, the degree of automation supported by the supply chain analyzed, and in general knowledge along the supply-production chain. Traceability system has to describe extensively to which the origin of all the raw materials used and the distribution of the finished products can be defined precisely and thereby could be identified unambiguously. Additionally, traceability system has to be able to identify which hazards are focused in the system as well as the specific time of the tracking-tracing practices (online, hours, days or weeks). Therefore,

accuracy, speed, completeness, reliability, validation and verification of the systems are important considerations in implementing traceability system

Bar codes are currently widespread used in tracking system as they offer several significant advantages. With an integrated system, the process of entering information into retailers' systems is automated so when new information is logged into the system by the producer, it is added in real time to all systems across a network. With such systems, anyone along the chain can track inputs, production, and inventory by an array of characteristics. However, RFID technology is known as the promising technology due to the higher accuracy and efficiency on identifying items compared to barcodes. By the time of reducing cost of production, RFID technology will be eventually replacing bar codes technology.

6. Conclusion

With increasing emphasis on traceability, exporting countries must earn consumer confidence in its products in order to enter the market. Lack of public confidence in the product of any country will lead to exclusion of that country from the international market and, at the same time, the country's own internal market may experience demand from affluent consumers as well as the tourist industry for food imported from countries that generate public confidence and consumer trust. Therefore, it is essential that each country "brand" itself as a trustworthy, safe producer and supplier that meets ethical and environmental concerns with focus on sustainability. The benefits of traceability system on food production and distribution will be achieved only if implemented comprehensively within all steps of food supply chain. As a whole we should understand that accuracy, speed, completeness, reliability, validation and verification of the systems are important considerations in implementing traceability system

Intellectual Property Rights with Special Reference to Fisheries

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Introduction

Intellectual property rights or Intellectual Property Rights (IPRs) are rights given to people over the creations of their minds. IPRs, which connote the rights available for the protection and exploitation of technology for the benefit of patentee, society, and government, occupy an important place in today's world. Intellectual property safeguards the rights of an inventor in his invention, and at the same time facilitates social and economic growth by providing an impetus to the advancement of science and technology. Unlike Fundamental Rights of citizens which are guaranteed by the Constitution of a country, IPRs are statutory rights enacted by the lawmaking authority in a country. With the development of new technologies a balance between the private rights and public interests need to be implemented, and there born the intellectual property system. The first intellectual property system came in from the West with the industrial development for the past four centuries. Through these years, IPR has converted from feudal power to people's private rights.

Types of Intellectual Property Rights

Intellectual property rights are divided into three main areas:

(1) *Copyright and Rights Related to Copyright*

The rights applied to authors of literary, dramatic and artistic works (such as books, publications and other writings, musical compositions, paintings, sculpture, computer programs and films). The main social purpose of protection of copyright and related rights is to encourage and reward creative works. The agreement says performers must also have the right to prevent unauthorized recording, reproduction and broadcast of live performances for no less than 50 years.

ii) Industrial Property

Industrial property includes:

- Trademarks (distinguish the goods or services of one undertaking from those of other undertakings), and geographical indications (identify a good as originating in a place where a given characteristic of the good is essentially attributable to its geographical origin).
- The trademark protection may last indefinitely, provided the sign in question continues to be distinctive.
- Patents, industrial designs and trade secrets are the industrial properties used to stimulate innovation, design and the creation of technologies. The protection under these categories is usually given for a finite term (typically 20 years in the case of patents).

Trademarks

Trademarks are any sign or combination of signs capable of distinguishing the goods or services of one undertaking from those of the other. TRIPS Agreement provides initial registration and each renewal for a term not less than 7 years and shall be renewable indefinitely. CMFRI has trademarks on "Preparation and filing of trademark registration application of mark Cadalmin" under class 31 (Food for fish, seeds) and "Preparation and filing of trademark registration application of mark Cadalmin" under class 35 (Trading and Marketing). The official registration of trademark 'CADALMIN' was done in the office of the registrar of Trademarks, India, Chennai.



Geographical Indications

Geographical Indications identify a good as originating in the territory, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin. Like TM, GI is a form of IPR used in product marketing, and is represented in words, figures, graphics, diagrammatic presentations or any specific combination of these indications.

Industrial Designs

Industrial Designs are protected for at least 10 years. The owners of protected designs must be able to prevent the manufacture, sale or importation of articles bearing or embodying a design, which is a copy of the protected design.

Patents

The patent law recognizes the exclusive right of a patentee by law to gain commercial advantage out of his invention with an idea to encourage inventors to invest their intellectual knowledge, knowing that no one else would be able to copy their

inventions for a certain period. The term of a patent in India is 20 years from the date of filing. However, for patents granted pursuant to applications filed under the PT, the term of 20 years begins from the international filing date. Patent protection is available for both products and processes. Patents provide the necessary incentive for inventors to undertake capital intensive projects knowing that they will receive the exclusive rights to profit from their inventions once they secure patents in respect of the inventions. The patentee also has the right to assign the patent, grant license, "or" otherwise deal with the patent, for any consideration (Article 28 of the Trade Related Intellectual Property Rights or TRIPS Agreement). The TRIPS Agreement is part of the "single undertaking" resulting from the Uruguay Round negotiations. This implies that the TRIPS Agreement applies to all WTO members, mandatorily. It also means that the provisions TRIPS agreement introduced intellectual property rules into the multilateral trading system for the first time and laid down minimum standards for protection and enforcement of intellectual property rights in the member countries.

At the end of the Uruguay Round of the General Agreement on Tariffs and Trade in 1994, the TRIPS agreement was implemented to regulate standards of IP regulations in WTO member countries. The Uruguay Round introduced IP rights into the multilateral trading system for the first time through a set of comprehensive disciplines. Being a member of the WTO and a signatory to the TRIPS agreement, it is compulsory for India to formulate its IP regulations to comply with the TRIPS agreement. TRIPS is intended to maximize the contribution of IP systems to economic growth through accelerating trade and investment.

(iii) Sui generis Systems

A "sui generis" system is a Latin expression, simply means "one that is of its own kind". In this case it refers to the creation of a new national law or the establishment of international norms that would afford protection to intellectual property dealing with genetic resources -or biodiversity - and the biotechnology that might result. It also refers to a law that might protect creations, inventions, models, drawings, and designs, innovations contained in images, figures, symbols, petroglyphs, art, music, history and other traditional artistic expressions. The diversity of the subject matter is one of the reasons why a sui generis system is not advisable, but there are other reasons as well.

Patents, industrial designs, integrated circuit designs, geographical indications and trademarks have to be registered in order to receive protection. Patents right, like all other rights conferred under this agreement in respect of the use, sale, importation or other distribution of goods, is subject to the provisions of Article 6. The registration includes a description of what is being protected-the invention, design, brand name, logo, etc. This description is for public information.

Types of Patent Applications

Standard Application

This is the most common type of application filed and does not refer to another application to claim priority. Standard application may be made with provisional or complete specification.

Patent Cooperation Treaty (PCT) Application

Patent Cooperation Treaty (PCT) is an international filing system for patents entered into force in 1978. India is a member of PCT. It is of note that India joined the PCT on December 7, 1998. The unified procedure for filing patent application under PCT grants an international filing date (priority date) in member countries. Later, the applicant can go to the national offices within 3 years without affecting the priority date. All activities related to PCT are coordinated by the World Intellectual Property Organization (WIPO) situated in Geneva. Indians can file PCT International Application either in Indian Patent office or in the WIPO. In order to protect any invention in other countries, it is required to file an independent patent application in each country of interest; in some cases, within a stipulated time to obtain priority in these countries. Inventors of Contracting States of PCT on the other hand can simultaneously obtain priority for their inventions without having to file separate application in the countries of interest; thus saving the initial investments towards filing fees, translation etc. In addition the system provides much longer time for filing patent application in member countries. The time available under Paris Convention for securing priority in other countries is 12 months from the date of initial filing. Under the PCT, the time available could be as much as minimum 20 and maximum 31 months. The inventor could also opt for preliminary examination before filing in other countries to be doubly sure about the patentability of the invention. The patent office or any other office designated by each Contracting state becomes a receiving office for receiving PCT patent applications. These applications are referred to International Searching Authorities (ISA), which usually the patent offices, appointed to carry out the patent search on a global basis. In case the receiving office is also an ISA, a separate referral is not required.

Divisional Application

When there is more than one invention is disclosed in main application, a divisional application can be filed. Divisional Application gains priority date of the main application.

Application for Patent of Addition

An application for patent of addition is filed when there is a modification or addition of already patented invention or application, within the term. In this connection it is to be noted that separate renewal fee is not required for patent of addition, and can be made independent to avoid the expiry of which with the main patent.

IPRs with Special Reference to Fisheries

Technologies in the fisheries can receive protection by patents, trademarks, geographic indications, and copyright, and design. These technologies receive protection by one or a combination of different IPRs depending upon the nature of technology (Ravishankar and Archak, 2000). Given the vast and unexplored potential of utilization of aquatic resources, the increasing trend in biotechnological patents in the developed countries, patenting of aquatic genetic resources will have an increasing trend in times to come. The use of aquatic resources has a significant potential in pharmaceuticals, nutraceuticals, high value compounds/chemicals, cosmetics and food.

The TRIPS agreement represents the existing global state of IPR standards and legally binds all its member countries. It is the only agreement amongst several multilateral agreements under WTO which have significant impacts on global trade (Maskus, 2000). The key element of the TRIPS agreement for the agricultural and fisheries sector is the requirement for WTO members to make patents available for any inventions in the sector. The most important article in the agreement when considering the agricultural (fisheries subject is included under agriculture) sector is Article 27, which state the patentable and non-patentable subject matter. According to the TRIPS agreement India had to provide legal protection to farmers' traditional knowledge (including that of fisheries) via patents or by an effective *sui generis* system or by both, by 2006. However, the agreement provides for each country to determine and adopt a suitable procedure to implement the provisions of the agreement within its legal system and practices. Developed countries like US and UK have adopted well-built IP regimes using strong patent systems in fisheries and agriculture sector, in general. The main reason for developed countries to choose patents for protection is due to their technological capabilities and the immense financial benefits that a patent system is expected to generate (Holger, 2001). Whereas, developing countries like India has weak regimes due to lack of financial and technical support. Most of the developing countries have faced several difficulties in protecting inventions related to fisheries which mainly attribute to lack of strong rules and regulations.

Improved breeds/ strains of fish cannot be protected in India as patents or variety protection. As per Section 3j of Indian Patents Act, no living organism as a whole obtained from nature can be patented. As per Indian Patent Act, Section 3(j), plants & animals in whole or any part thereof other than GMO and essentially biological processes for production or propagation of plants and animals are not patentable in India. However, IPA allows for patenting whole organisms like transgenics, with human intervention. National Bureau of Fish Genetic Resources (NBFGR) has been identified as a nodal institute to develop a system to register and document valuable fish genetic resources by ICAR. The registration system will bring elite germplasm into public domain to promote its use in research. However for elite fish genetic material in the public domain, there is no IPR enabling provision under the existing Indian laws nor is there any provision for the registration and documentation of the breeds and strains of fish developed by ICAR. To check their misuse or exploitation, "ICAR will develop a system of their registration and documentation, at the respective National Bureaus of Animal and Fish Genetic Resources for quickly placing them through disclosure in the public domain thereby forestalling any

unforeseen patenting in other countriesand to establish a system of their registration and documentation. It will suitably extend the existing system to register and document the elite and new breeds/strains of fish developed in ICAR, at the National Bureau of Fish Genetic Resources (NBFGR)" (ICAR, 2006).

In recent times among the Indian organizations, CSIR along with other private industries are the major patent applicants in India and US, the rest of patent applicants are foreign individuals. There is also lack in continuity in patenting activity for the last four decades from 1920-1950 in the field of aquaculture. However, in recent years (after 1996) there are incremental trend in patent filing in ICAR institutes including fisheries. Among fisheries, a maximum of 55% of patents have been granted in the field of processing technology followed by 24.5% in fishing technology and about 21% in aquaculture. Among fish processing technology, about 43% of the patents granted to the foreign nationals, and about 15% to CSIR in the subject area of extraction and isolation of polysaccharides and protein from marine organisms, fish oil originated fat liquors, alkaloid from sponge etc. In post WTO era (1996-2000), the average number of patents granted in fisheries discipline is six in a year. Increasing awareness for patent search engines/sites, access to patent information, and the comparatively easier administrative procedures in the amended patent laws are among various reasons for increased patenting activity. In aquaculture too, the majority of patents (45%) granted in India are to the foreign nationals (Ninan et al., 2005). Since the innovations in processing technology can be varied easily in the process patent application area, and are easily imitable towards various directions, there appeared to be greater trend to incline for processing technology in fisheries subject. Importance of processing technologies with respect to export and trade in and outside India also are the reasons that hold the edge towards patent application in India as compared to other subjects in fisheries like aquaculture, machinery or fishing technology. This is also an example that demonstrates the fact that process patents provides stimulus for dynamic competition wherein the same product is manufactured by different processes. The patents on method for obtaining carrageenan, chitin, phycocyanin, and products from spirulina, polyunsaturated fatty acids, bioactive compounds, alkaloids and other bioprocessed products. In recent times seaweeds and marine plants have been identified as valuable resources to isolate bioactive molecules for use against different diseases. However, this area is vastly unexploited and after implementation of the product patent regime in 2005, research and patenting activity in this sector could rise.

It is of note that around 46% of the total patents granted in fisheries sector during the post WTO era (1996-2002) are in processing technology. A total of 27.93% of patents applications related to water treatment, waste water treatment, power and electricity generation from sea waves, river bank protection, manganese nodules, purification of microbes in water, etc., whereas 14% of patent applications relate to aquaculture, and about 12% patent applications relate to fishing technology.

Marine Fisheries and IPR

Earth's surface covers more than two-thirds water with five large oceans, which offer an ecosystem for the growth of various forms of lives with unique properties, which

are generally not present in the terrestrial ecosystem. Historically marine ecosystem and marine biodiversity benefited mankind through direct and indirect economic benefits and industrial means. However, there is a high degree of representation of terrestrial-derived bioproducts, but the number of patents that have found their way into IP protection from marine origin is thus far small.

Marine organisms have various biotechnological applications in the area of health, environment and mariculture. As compared to terrestrial ecosystem very meager is known and explored from marine environment probably because of the difficulty in reaching the depths. The areas of patenting in marine fisheries sector includes the technologies and methodologies in fishing, processing, and aquaculture/mariculture (with intervention), pharmaceuticals, nutraceuticals, cosmetics, food and feed, bioactive compounds, etc. Central Marine Fisheries Research Institute pioneered in shaping a number of IP protected technologies and their commercialization, which are of direct or indirect benefits to the society and mankind. The technologies have been developed in marine fisheries in India for land-based culture of pearls, fish strains, packages of improved marine finfish and shellfish husbandry practices, natural resource management technologies, improved tools including cage culture technology for open sea fish farming, technologies for making nutraceuticals and value added products, and several other processes and products related to fisheries sector, some of which have been safeguarded by patents. A patent protected product Cadalmin™ Green Mussel extract (Cadalmin™ GMe) containing anti-inflammatory principles from *Perna viridis* to combat joint pain, arthritis/inflammatory diseases developed by CMFRI as an effective green alternative to the synthetic drugs available in the market (Indian Patent Appl. No. 2065-2066/CHE/2010). CMFRI has taken the lead to develop a nutraceutical supplement with concentrated anti-inflammatory principles as Cadalmin™ Green Algal extract from seaweeds for use against joint pain and arthritis (Indian Patent Appl. No. 2064/CHE/2010). Design, development and propagation of open sea cage device for cultivating marine fishes along the coastline of India (Indian Patent Appl. No. 31/CHE/2010), cutting edge mariculture technologies of food fishes such as cobia (*Rachycentron canadum*), silver pompano (*Trachinotus blochii*) and *Etroplus* sp are some of the success stories of marine fisheries and CMFRI. CMFRI showed the way of land-based culturing of pearl oyster in marine body (Indian Patent Appl. No. 1543/CHE/2009), open sea green mussel and oyster farming, hatchery technology for production of ornamental fish (Indian Patent Appl. No. 3455/DEL/05), edible clams, sea horse, mass scale spat production of green mussel, artemia selective breeding to impart high value traits for use in mariculture (Indian Patent Appl. No. 2063/CHE/2010), biotechnological interventions to control fish diseases and maintain fish health, probiotics, bioprospecting beneficial microorganisms for aquaculture grade antioiotic substitute, biocatalysts from beneficial bacterial flora (Indian Patent Appl. No. 203/CHE/2008), PCR kits to manage various fish diseases, gene mining technologies for various important traits, cost effective and rapid duplex PCR kit for early detection of white spot syndrome virus of shrimp, phytoplankton culture and algal biotechnology, production process for sea cucumber *Holothuria scabra* and *Holothuria spinifera* seeds or fingerlings, resource management of the Indian sacred chank, *Xancus pyrum* (= *Turbinella pyrum*) by breeding, nursery rearing and sea ranching, propagation of soft coral *Sinularia kavarattiensis*, fish aggregating devices (FAD), Cadalmin™ Varna (Indian Patent Appl. No. 32/CHE/2010) and Cadalmin™ Silo fish feed, capture based aquaculture of mullets and red snapper, lobster farming in floating

sea cages, mud spiny lobsters (*Panulirus polyphagus* fattening in sea cages), image pearl production, which are of direct use of the fish farming communities.

Conclusions

Fisheries in India are in need for strategic and proactive research based inventions to make the subject technically sustainable, environmentally friendly, economically profitable and socially relevant. With the fast changing fisheries scenario and emergence of aquaculture as an alternate approach for enhancing fish production, the fisheries in Indian context has tuned its mandate in consonance with the need of the time.

The patent system involves the balancing of competing interests. While patent holders seek monopoly rights to make, sell, and license the patented invention towards maximizing their profits, many consider this as detrimental to the interests of society as patentees have the discretion of charging their own prices for their products. While these misgivings might be true to an extent, in reality the society's interests are protected rather than derided by the patent system. As the inventions for which patents are granted are accompanied by an enabling disclosure, competitors often use this information to produce improved products and patent them. Their improved products being also accompanied by enabling disclosure, provides the necessary base for further improvements. Thus consumers benefit as the patent system automatically leads to an increased choice in the market and patent holders benefit as they can focus their energies on providing new and improved products based on the consumers' preferences.

Indian coastline is gifted with an enormous resources of valuables hidden into the depths of sea, and can be explored to develop products with valuable patent protected nutraceutical, pharmaceutical and biomedical products for human health and well being. In this connection it is essential to develop knowledge in IP and patent protection of technologies developed by the inventor(s). Intellectual property system safeguards the rights of an inventor in his invention/ intellectual richness while benefiting the end users and society as a whole. The IP system operates towards securing its objectives as follows: ".....protection and enforcement of intellectual property rights should contribute to technological innovation and to the transfer and dissemination of technology, for the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations." The purpose of an invention is to protect and encourage fair competition in the field of technology so as to transform inventions or creations into real and productive forces. Intellectual property is an important and effective policy instrument to a wide range of socio-economic and technological concern. It is to be remembered that the possession of a patent not only confers certain monopoly rights and privileges of the patented article, but certain obligations and duties also. Commercialization of IP-enabled technologies is an absolute necessity to transfer valuable technologies developed in the institute laboratories to the society for greater benefit of mankind.

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**Responsible Fisheries
Management:
Human Dimensions**

Responsible Fisheries Management and Extension in Coastal Fisheries

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In developing Countries, the major aim of extension education is to change the traditional way of adopting the low yield technologies and production enterprises through extension interventions. These extension interventions in public or private domain change the behavior of clients in terms of their attitude, knowledge and skills. The change in behavior of stakeholders thus results in improved production, better living and improvement in the national economy. Extension education in fisheries aims to disseminate the various improved practices or technologies and assist them to adopt the innovations.

The annual marine fish production in India is estimated around 3.3 million tonnes and the country has exported about 9.28 lakh tonnes of marine products earning about USD 3.51 billion (Rs.18,856 crores) during 2012-13. It is estimated that in India about 25% of 8.5 million fisherfolk are actively engaged in fishing and these people are living in 3288 villages in the various coastal states and union territories. One of the primary roles of extension in marine fisheries is to increase the fish catch by transferring the proven technical know-how to the actual users. India has a vast potential for fisheries development. For example, in the marine sector it possesses, along a coast line of nine marine states, over 20 lakhs sq.km of Exclusive Economic Zone (EEZ), of which 4.15 lakh sq.km is the continental shelf rich in demersal and midwater fish resources. About two-third of marine fish production is contributed by 1.8 lakh motorized and non-motorized fishing crafts and the remaining one-third comes from about 59,000 mechanised boats.

Responsible fisheries codes requiring extension interventions

By the late 1980s, it became clear that fisheries resources could no longer sustain rapid and often uncontrolled exploitation and development, and that new approaches to fisheries management embracing conservation and environmental considerations were urgently needed. The code of conduct for responsible fisheries which was unanimously adopted on 31st October 1995, by the FAO conference provides a necessary framework for

national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment.

In this context, the following responsible fisheries codes requires attention in fisheries extension interventions so as to promote voluntary acceptance of the codes and their effective applications.

- ❖ Usage of improved gear/ practice to increase fish catch and at the same time, **avoidance of over fishing**
- ❖ Usage of improved gear/ practice to **conserve fishery resources**
- ❖ Usage of method to **reduce fuel consumption** for responsible fishing and energy optimization
- ❖ Observance of Government **fishing holidays like monsoon trawl ban**
- ❖ Usage of measures to **avoid catching non-target fishes** during fishing trips
- ❖ Usage of measures to **avoid catching of juveniles**
- ❖ Usage of measures to **avoid pollution of sea** and waste disposal to protect coastal areas
- ❖ Observance of government **restrictions on fishing in some selected areas** for conservation
- ❖ Following regulations or restrictions imposed by local people/ bodies for protecting fishery resources and to **minimize the adverse impacts on the environment due to aquaculture**
- ❖ Promoting the contribution of fisheries to food security and food quality, **giving priority to the nutritional needs of local communities**
- ❖ Promoting the protection of living aquatic resources, their environments and **management for sustainable fisheries**
- ❖ Ensuring good fishing facilities and equipment assuring **safe, healthy and fair working and living conditions**
- ❖ **Conservation of biodiversity** of aquatic habitats and ecosystems and protection of endangered species
- ❖ The **harvesting, handling, processing, and distribution** of fish and fishery products have to be carried out in a manner which will **maintain the nutritional quality and safety of the products**, reduce waste and minimize negative impacts on the environment.

Socio-economic profile of marine fisherfolk

In the micro level studies conducted by CIFT, (Balasubramaniam and Ashalatha, 2007), it was found that in fishing villages studied, even though the artisanal fishermen have more or less a common life style and social background, the ownership pattern of fishing craft and gear, and individual status varied between the geographical regions in a state and also between the states. The general characteristics of traditional fishermen included illiteracy/ low education level, employment in fishing for 200-300 days per year, underemployment due to off-season in fishing, annual income of around Rs.25000, dwelling in huts or semi-pucca houses, poor socio-economic living conditions and amenities, low investment and variation in ownership pattern of fishing craft and gear, less

fish catch due to non-availability or depletion of resources in nearby areas, unfavorable weather conditions and seasonal availability of fish. During offseasons, as the fish catch is very less, it results in getting loans for meeting the operational expenses in fishing, consumption expenses and other necessities. Chances of getting lower price for their catch, and uncertainty in prices during sale are found to be the reasons for their poor motivation for adoption of innovations.

It is reported that the fishermen operating catamarans (6-7 m LOA) had obtained an average fish catch of 40-60 kg perday per craft, and their annual income was about Rs.10,000 to Rs.13,000. The fishermen operating small FRP crafts (8.5 to 9.25m) had obtained a mean fish catch of 100 to 155 kg/day, and their annual income was about Rs.40,000/ to 1.5 lakhs. It is seen that the fishermen operating large plank built crafts (15 to 17 metres) had obtained an average fish catch of 550 kg/ day and their annual income was about Rs.40,000 to Rs.1 lakh due to higher operational expenses and size of crew (30 to 35). For mechanized fishing boat owners operating smaller boats (11.5 to 12.5 m LOA), the average annual catch varied from 40-100 with an annual income of Rs. 3 to 5 lakhs.

The key roles identified for extension education for responsible fisheries management are as follows:

- a) Avoiding indiscriminate trawling and use of trawl cod ends with less than legal mesh size, catch of juveniles and discards/non-targeted species.
- b) Use of improved trawl designs and large scale adoption of square mesh cod ends for the exclusion of juveniles.
- c) Regulating the operation of ring seines and standardization of ring seine units for optimum exploitation.
- d) Area-wise optimization of fishing fleet size and fleet categories to reduce over exploitation
- e) Regulation of fishing by chartered foreign vessels and providing information on potential fishing grounds
- f) Use of By-catch reduction devices and Turtle Excluder Devices.
- g) Awareness on modern fishing techniques and hygienic on board handling of fish
- h) Extension schemes to increase the awareness of improved fishing nets and practices, and to facilitate capacity building programmes.
- i) Improvement of socio-economic conditions of fisherfolk through development programmes.
- j) Usage of methods to reduce fuel consumption for responsible fishing and energy optimization.
- k) Encouraging small scale fishing and schemes to own fishing units among artisanal fishermen

Extension Approaches

Different extension educational approaches were used in the past under the extension educational programmes. These approaches can be grouped under seven main headings: 1) the educational approach, 2) the training approach, 3) the cooperative self-

help approach, 4) the integrated development approach. 5) extension service approach 6) people participatory approach and 7) project approach. These are not watertight, mutually exclusive compartments, nor are they purely educational classifications. They differ mainly, not in their educational principles and methods, but in their quite different underlying conceptions and theories of rural development.

1. Educational approach

The educational approach uses the extension methods for educating the people. It believes that the extension can transform static economy into a dynamic economy. While improving the quality of life, it emphasizes the communication of information about innovative technical practices. It is mostly followed in America and Asia and is referred to as the classical model of extension.

2. Training approach

The training approach is considered to be related to the educational approach. It emphasizes more systematic and deeper learning of specific basic skills and related knowledge. The trained extension workers are supposed to transmit the useful knowledge gained by them to the rural people. The training and visit system is a good example of the training approach. The training and visit system evolved by Benor and Baxter (1984) was used in most of the developing countries with assistance from the World Bank to reduce the technological gaps.

3. Cooperative self-help approach

The cooperative self-help approach starts with the assumption that the complex process of rural transformation must begin with changes in the rural people themselves. The chief motive power for development must come from the people so that outside help of various kinds can be provided in response to the expressed needs of the people. There is heavy emphasis in this approach on the building of local institutions for cooperative self-help and governance.

4. Integrated development approach

The integrated development approach emphasizes the need of coordinating different agencies under a single management system of essential components required to get rural or fisheries development moving. The management system may be authoritarian. The main emphasis is on rational development and coordination of all principal factors required for rural and fisheries development. Fish Farmers Development Agencies (FFDA) in India used this approach in tackling the problem of inland fisheries development.

5. Extension service approach

Extension service approach is followed when an organization employs the extension process as a means of programme implementation. Here, the extension organizations often provide one or more supply and services such as credit, key inputs like fertilizers, seeds, pesticides, herbicides, etc. with or without subsidy.

6. People participatory approach:

This is based on the experience that much can be achieved when rural people organize for their own benefit. It assumes that farmers are knowledgeable regarding food production but they can also benefit from outside experience. Programme planning and staff are usually controlled by local people. The approach tends to be more efficient, since programmes tend to fit the needs and interests of local people.

7. Project approach

The project approach assumes that large, nation-wide extension is likely to be ineffective, so a small area is designated for a period of time and resources are poured. The assumption is that benefits demonstrated within the project area can then be replicated elsewhere. They tend to be controlled by officials, and have the advantage of focus.

Adoption of responsible fishing technologies

In the field of fisheries technology, a new idea cannot be transferred to the fishermen so easily. Education of fishermen and rural people is not the same as educating the organized clientele categories in the industrial sector. Educating rural people involves convincing them about the new knowledge in their fields or situations to produce more and live better. Rural people, particularly adults, can be convinced of improved practices only when knowledge is carried to them in a convincing way. Even when they are convinced, the decision to apply the knowledge to their specific local situation has to be made by themselves for sustainability.

Factors related to adoption of technology:

1. Social factors: When there is great emphasis on maintaining traditional ways, rate of technology adoption will be very slow.
2. Personal factors: It was found that people who are mentally flexible, more educated and having contact with research and development agencies, adopt the technology more quickly than those who are mentally rigid, less educated and having less/no contact with outside agencies.
3. Quality of technology
 - a) Complexity: Generally speaking, the more complex a technology and more change it requires in the existing operation, the more slowly it will be adopted.
 - b) Cost: Those technologies which cost less seem to be adopted more rapidly than those which are more expensive.
 - c) Net returns: Technologies which yield the greatest marginal returns in the shortest time seem to be adopted most rapidly.
 - d) Compatibility: A technique which is not compatible with the cultural norms of a social system will not be adopted so readily.

- a. Divisibility: an innovation that can be tried in small installments will generally be adopted more rapidly than a technique which cannot be tried with small investment.
- b. Communicability: If the result of a technology is easily diffused or communicable, its adoption rate will be very high.

Extension methods

The technologies developed in research institutes are transferred to the end users by different extension methods. Extension methods are classified as (1) individual contacts (2) group contacts and (3) mass contacts.

Extension methods to a particular situation have to be carefully selected taking into consideration the facilities available in the extension organization, number of staff, budget allocated, knowledge level of the clients, nature of technology etc.

Extension Management Constraints

As the fisheries extension work comes under the States' subjects, the analysis of extension management by the various State and Central Government Organizations, and Non-Government Organizations would help to activate the extension delivery mechanisms and also to improve the extension organizational development programmes. Some of the important management constraints are listed below :-

- 1) In extension organizations like State Fisheries Departments, the work is compartmentalized such as marine fisheries, freshwater aquaculture, brackishwater aquaculture, etc. and even within a sector, extension forms only a part besides activities such as administration, conservation and licensing, research, fish seed farms, marketing, etc. In some departments, the officials are designated as Fisheries Extension Officers and in some States, they are designated as Sub-inspector of Fisheries/ Inspector of Fisheries and as a result, extension approach is not followed. The number of fisheries extension officials working in a district or taluk levels are highly inadequate and usually, they have to cover more villages for extension work. For field activities, they don't get vehicle facilities, and teaching aids and equipments. The budget allocated for extension work is inadequate and comprehensive schemes are required to provide the key inputs with extension educational activities. In several States, the private agencies provide the inputs and technical guidance on commercial basis.
- 2) In extension organizations, the personnel management policies such as the periodical in-service training of extension officials, transfers and postings of suitable persons, promotional opportunities, improving job satisfaction, and timely recruitment for various vacant posts play an important role in bringing out efficiency in extension management (Balasubramaniam and Perumal, 1991). As ICAR Fisheries Research Institutes have all facilities and expertise to train the extension officials, they may have to be deputed at least once in five years for imparting the advances made in the technological sectors.
- 3) All research innovations cannot be adopted in the field, as they have varied attributes such as profitability, initial investment, complexity, local compatibility,

direct and indirect impact, availability of inputs, and other relative advantages of adoption. Hence, target based appropriate technologies have to be selected for wider adoption and popularization, and on such technologies, the extension efforts will be more useful. Many of the technological practices need higher investment on account of costlier inputs. When there is no substantial increase in income to the corresponding increase in expenditure, financial constraints are often reported as the reasons for the non-adoption of innovations.

- 4) In the extension organizations, appropriate technological schemes have to be planned and implemented to popularize the selected innovations. Starting separate extension units alone will not be sufficient if they are not empowered to provide the required key inputs. Providing infrastructural facilities and operating welfare schemes take a major share of the budget allocations and for effective transfer of technologies, adequate schemes have to be implemented. As the innovations are resource-specific and target oriented, constant monitoring and supervision are required to achieve the goals.
- 5) For strengthening interpersonal communication, local leaders, key communicators and cooperative clients have to be identified and trained in the technological subjects. District level Fisheries Training Centres and Krishi Vigyan Kendra may have to increase the number of training courses and trainees to provide the information support. Wider coverage by mass media channels such as the use of extension publications, exhibitions, radio and TV programmes may have to be periodically carried out to spread the innovations among the targeted audience.
- 6) Participatory management style at different levels is being followed for improving the socio-economic conditions of people engaged in fisheries. In community based fisheries management, fisherfolk and their NGOs have many roles as protectors and managers of coastal environment and resources.
- 7) In several areas, the environmental factors such as the use of Coastal Regulation Zones, the destruction of mangroves and conversion of agricultural fields, increase in soil salinity, environmental pollution due to industries, change in rainfall pattern, contamination due to heavy metals, antibiotics, pesticides and other toxic elements, and improper disposal of wastes influence the extent of adoption of innovations, and these areas need special attention and, policies to meet the constraints.
- 8) Non Governmental Organizations have important roles to motivate the organized groups of people to adopt the innovations, to facilitate the purchase of key inputs, to get credit facilities from banks, to provide technical guidance by availing the assistance of Government departments and to market the output without the exploitation of commission agents so as to improve the net earnings of the members. These NGOs could be effectively involved in technology transfer work, and they minimize the Government efforts and resources.

Conclusion

To conclude, though, there are several subject areas for responsible fisheries management in coastal fisheries, appropriate technologies have to be selected by the extension organizations for popularization and wide scale adoption among the targeted stakeholders. Without specific projects and allocation of funds, extension interventions will not occur in several situations due to the various constraints. Hence, even small scale pilot projects could be implemented in different centres and the successful technologies could be extended to several other centres

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Extension Education in the Changing Times

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Introduction

**“Give a fish to a man; you are feeding him for the day
Teach him how(NOT) to fi(NI)sh; you are feeding him for the life”**

The above maxim is an evergreen explanation of the concept and importance of Extension Education. Now with the emphasis on sustainable resource management, teaching how to fish has wider ramification. This leads us to the transcendental significance of ‘Responsible Fisheries Management’, which in turn unfolds the emerging challenges to Extension in the Fisheries Sector. Ensuring the livelihood security of the fisher folk through mussel, seaweed and open sea cage farming and other options warrant nurturing of their social entrepreneurship. The scintillating developments in the information and communication technology including hybrid communication tools have thrown open new vistas in fisheries extension. An attempt is made here to develop a framework for revitalizing the Indian fisheries sector through the emerging extension approaches.

Extension: The unfolding scenario

Extension and advisory systems generally focus on four major types of objectives, including

- 1) technology transfer, especially for the primary production sector; 2) human capital development, especially the technical and management skills and knowledge that poorly educated people need to increase their income; 3) building social capital, or getting people organized into producer groups or other types of organizations to carry out specific activities, ranging from supplying high-value products to urban markets to managing watersheds; and 4) educating rural communities to utilize sustainable natural resource management practices.

Technology Transfer

The technology transfer function will become increasingly privatized as technologies become progressively more proprietary and as farmers become more commercialized. As this transition occurs, more and more of the cost of providing technical advisory services to farmers will be recovered through the sale of production inputs and services.

However, in most developing countries, there can and should be closer cooperation between the public and private sectors because many input suppliers do not have technically competent sales personnel who can give correct technical advice to farmers. Therefore, rather than public extension personnel viewing the private sector as competitors, they should develop public-private partnerships with input supply dealers because these firms provide most of the one-on-one technical advisory services.

Human Capital Development

The second extension function is to increase the technical and management skills of all types of farm households. First, it is essential to differentiate among different types of farm households (small-scale/subsistence, medium-scale, and larger/commercial farm households) and differences among men, women and rural young people within the household. Small-scale subsistence farmers and farm women generally lack basic education; therefore, their needs differ substantially from the skills needed by medium-scale and, especially, commercial farmers. Also, the role of women within households differs considerably across different cultures, agro-ecological zones and farming systems.

Social Capital Development

In most developing countries, public extension systems have been discouraged from organizing farmers, farm women and rural youth, because these groups could place political demands on the national government. In addition, extension's focus has concentrated on technology transfer for the major food crops; therefore, social capital did not play an instrumental role in this earlier agricultural development strategy. However, in addition to organizing producer groups, it should be noted that organizing rural youth groups is an effective, long-term strategy of building human and social capital within rural communities.

Sustainable Natural Resource Management

The combination of the growing world's population, economic growth and limited natural resources, especially in many developing nations, is creating serious long-term sustainability problems for the world's natural resources. During the past 20 years, worldwide expansion of arable cropland has diminished considerably, yet to meet the 2050 Millennium Development Goal on world hunger, world food production must double. In spite of these growing food demands, soil nutrient depletion is occurring in many tropical and subtropical countries, and land degradation and desertification continues to progress in

many other countries. Also, water scarcity is a serious problem threatening food security in a number of countries due to poor water-use management practices being followed by most farmers. In short, in most countries there is an urgent need for public extension and advisory organizations to allocate more resources and effort to educating farmers how to use sustainable natural resource management practices and to adopt these practices continuously in order to cope with the impact of climate change.

Developing Comprehensive, Sustainable Agricultural Extension Systems

By analyzing these differing needs across rural communities and farm households, it is easier to understand the various, but related, roles that extension can play in serving the needs of these different clientele groups, especially in providing the necessary technical and management skills for them to diversify into new crop, livestock or other enterprises. However, in the emerging global agricultural economy, this top-down, technology-driven extension system no longer appears to be an appropriate model. If public extension systems are going to be effective in improving rural livelihoods, then they must change their focus, structure and approach.

The other issue to be addressed is the potential role of private-sector firms and CSOs in undertaking specific extension activities. With sufficient funding, many private-sector firms can organize, manage and deliver extension services more efficiently than government agencies. For example, in some countries, private-sector firms can hire, fire and compensate employees based on performance; therefore, they may be able to successfully deliver extension programmes as long as there is adequate funding. However, if these extension activities are publicly funded and public funds decline as governments attempt to shift the cost of extension services to the farmers themselves, then most private-sector firms will shift their focus to alternative funding sources and abandon these extension activities. At the same time, other successful examples are emerging about how private-sector firms and farmer-based organizations are establishing their own extension services for very high-value products, especially for export. Because these commodity-based extension activities are critical to the economic success of the private-sector company, then such efforts will progressively grow with the market. On the other hand, their overall national impact will be limited because they can reach only a small fraction of the farming community.

In a number of countries, the recognized need to organize farmers into producer groups and organizations has prompted some NGOs to become engaged in the social capital dimension of extension activities. Because these NGOs have employees who are socially committed to helping rural people, they can play a significant role in building social capital within rural communities. However, most NGO employees or volunteers are often not sufficiently technically trained in specific agricultural fields (e.g. horticulture, livestock and fisheries) and therefore cannot provide the necessary technical and management training that producer groups will need to successfully produce for and supply different markets. Consequently, whenever possible, local NGOs should be used to initiate social capital development in rural communities, but they will need to partner with agricultural extension workers or specialists to provide the appropriate technical and management training to these different producer groups.

Thus, there is a clear role for public, private and civil society organizations to work together in providing extension services to rural farm households within a broader agricultural innovation network. However, each type of organization has its own comparative advantage in providing specific services. Because public extension systems are government agencies, in the past they were generally “top-down” in structure, and they protected their recurrent budgets by allocating too many resources to staff salaries and benefits. In an effort to reduce government spending, the operational and program budgets of public extension systems are typically cut to a minimum (< 20 percent), with sufficient funds to cover only limited travel and office expenses (e.g. telephone and electricity). With few exceptions, adequate program funds are seldom available for field-level extension staff to provide specific technical and management training and other services to producer groups, based on local needs. Also, in most countries, few funds are available to cover the cost in-service training courses that can be used to upgrade the skills and knowledge of field extension staff. Given the number of farm households to be served, the “top-down” structural problems, the lack of well-trained staff, and the inadequate program resources at the field level, is there any wonder why the performance of public extension systems has been inadequate? Unfortunately, based on the experience in Latin America and elsewhere replacing these public extension systems with private-sector firms and/or NGOs will likely result in another set of problems and constraints that may further limit the success of these alternative approaches. Nevertheless, the importance of human resource development and building social capital among the rural poor makes it essential to reorganize and strengthen public extension systems within an agricultural innovations framework so that these institutions can develop public-private partnerships, based on comparative advantage, with private-sector firms and CSOs.

Extension in the Globalizing Era

Two new sets of conditions have to be faced by developing countries and have important implications for extension:- One is globalization, especially in respect of trade in agricultural commodities. The implication for extension is clear-all aspects of production, processing and marketing need to be driven by the requirements of the market and extension guidance has to be tailored accordingly. The second condition is the growing concern among donors that their support for extension should be geared towards poverty reduction. This poses the interesting question of whether extension can contribute towards poverty reduction. Extension can contribute in this respect only as long as poor people are seen to be not just farmers but also laborers and consumers.

Emerging Roles of Extension

During colonial and early post - colonial periods, farmers were treated as passive recipients of technologies designed and delivered from scientific centers. Later on, extension integrated the farming systems approach, got interested in Indigenous Technical Knowledge and adopted the farmer - participatory approaches to technology generation and transfer. With the demands and expectations on the extension systems continuously

increasing, the following new roles have to be added to ensure that extension facilitates equitable and sustainable development.

1. Identification of different nodes in the innovation system and evolution of mechanisms to bring them together around its objective and facilitate capacity building among these actors.
2. Negotiation and management of a series of relationships at different levels with diverse organizations
3. Provision of information on wider livelihood choices and institutional support available.
4. Bridging organizations that can access knowledge, skill and services from a wider range of organizations to meet the needs of the clients.
5. Enabling producers and rural poor to form viable economic organizations.
6. Promotion of information flow, sharing perspectives and facilitation of learning among the different actors, and
7. Experimentation with and learn from new technological and institutional innovations.

Approaches to Extension

The major approaches to extension could be categorized into:

1. Farmer-to-farmer approaches, in which farmers themselves are trained to promote learning among their colleagues and to make demands on external systems.
2. Experiential learning approaches, such as farmer field schools where emphasis is on the importance of learning in practical field settings instead of through didactic modes in classroom settings.
3. Soft systems approaches such as the Agricultural Knowledge and Information System (AKIS) to think about the institutional framework supporting extension and to identify the roles played by different kinds of actors in different settings.

Good Extension Practices

A scrutiny of the extension approaches which are proving to be successful such as the Farmers Field Schools, Campesino a Campesino, Land Care, Nayakrishi Andolan, People's Plan Campaign, Group Farming Programme, KHDP etc. reveals the emphasis placed on the following Good Extension Practices.

1. Development of low external input agro-ecological agriculture.
2. Off- farm and non-farm income generation.
3. Strengthening of local value.
4. Knowledge based decision making.

5. Enhancement of Social Capital.
6. Participatory analysis and planning.
7. Farmer-to-farmer exchange and learning.
8. Farmer experimentation.
9. Participatory monitoring and evaluation.
10. Integration of indigenous and scientific knowledge.
11. Motivation and retraining of extension personnel.
12. Promoting farmers' movements and institutional innovations.
13. Encouragement of interdisciplinary, holistic and social learning.
14. Systems approach.
15. Strong alliances among the stakeholders.

Scaling up of Good Extension Practices

Many success stories of approaches with 'Good Extension Practices' are increasingly being reported from various parts of the world. Attempting to achieve the principles and objectives of sustainable use of environmental and other resources for productivity enhancement and poverty eradication, most of these locale -specific extension approaches have the potential of 'scaling up' or mainstreaming 'leading to more quality benefits to more people over a wide geographic area more quickly, more equitably and more lastingly'. Thus, the Quantitative, Functional, Political and Organizational types of scaling up have to be reckoned in the context of mainstreaming Good Extension Practices.

Dimensions of good Extension Practices

On an analysis of the foregoing and based on the experiences in this regard from India and abroad, the following dimensions of Good Extension Practices could be delineated:-

1. Participation of stakeholders in analysis, planning, experimenting, implementing, monitoring and evaluation.
2. Sustainability in terms of the capabilities of institutions and individuals.
3. Empowerment of people on entitlements etc.
4. Adaptability in varied agro-socio-technical systems.
5. Sensitivity to gender, social, economic and technological divides.
6. Efficiency in terms of cost, personnel, efforts and time.
7. Integration of forward and backward linkages and information.
8. Decentralization - Shift from Top-down to Bottom-up.
9. Flexibility of methodology conducive to promote human relationships.
10. Emancipation of the deprived including the marginal farmers, the landless and the agricultural laborers.

Practice - Dimension Matrix for Good Extension.

Hypothetical Practice – Dimension Matrix for Good Extension *

Name of Dimension	Name of Approach /Practice	Dimension 1	Dimension 2	Dimension 3
FFS	Practice I	$P_I D_1$	$P_I D_2$	—
	Practice II	$P_{II} D_1$	—	$P_{II} D_3$
	Practice III	$P_{III} D_1$	$P_{III} D_2$	—
WCCP	Practice A	$P_A D_1$	$P_A D_2$	$P_A D_3$
	Practice B	$P_B D_1$	—	$P_B D_3$
	Practice C	$P_C D_1$	$P_C D_2$	—
BARC MPP	Practice a	$P_a D_1$	$P_a D_2$	—
	Practice b	—	$P_b D_2$	$P_b D_3$
	Practice c	$P_c D_1$	—	$P_c D_3$

* One Practice can cover many Dimensions and one Dimension can exist in many Practices.

From the preceding descriptions of the Practices and Dimensions of Good Extension, it could be deduced that there is a flux in the relationships between these practices and Dimensions i.e. One Good Extension Practice entailing a number of Dimensions of Good Extension and one Dimension of Good Extension being enshrined in a number of Good Extension Practices. This synthesis yields the Practice - Dimension Matrix for Good Extension as has been illustrated with a few examples from the Good Extension Practices followed in the Farmer Field Schools (FFS), Women in Cattle Care Project (WCCP) and BARC Model Poultry Project (BARCMPP) approaches followed in the developing countries.

The Context of the Transformational Model of Extension

A desk-review of traditional and transitional models of extension education and meta-analysis of data from research studies on the current extension and advisory services were made. These yielded an array of Good Extension Practices (GEP) which constituted the dimensions of the transformational model of extension education (Table 1). The critical dimensions such as leadership, focus, locus, nature, drivers, cost, sustainability and equity essential for '*farmer first and last*' extension have been examined in both thematic and programmatic perspectives in the model utilizing the practice-dimension matrix developed by Bhaskaran (2004).

Table 1. Transformational model of Extension

Sl. No.	Type Feature	Traditional Models	Transitional Models	Transformational Models
1	Period	Prior to 1990s	1990-2010	Post Recession
2	Leadership	Legitimiser , State, Official	State, Official, Business	Business, CSO, FEO
3	Focus	Human Capital	Human and social Capital	Human, Social and Natural Capital
4	Locus	Localised	Globalised	Glocalised
5	Nature	Monolithic , Directive	Semi-flexible, PPP	Dynamic, PPPPP
6	Drivers	Supply driven	Market driven	Farmer driven
7	Cost	Free	Fee based	Profit sharing
8	Sustainability	Incentive prone	Innovation prone	Internalisation prone
9	Equity	Access based	Asset based	All inclusive
10	Examples	Pre-Independence Indian Models, Package Models, T&V Model, T & D Model	ATMA Model, Farmer Business School Model, LEADS, ATMA PLUS	No Magic Model, One Size Doesn't Fit All, Best Practices Mix

The fine-tuning of the model in the context of the peculiarities of Indian Agriculture resulted in the 'best practices mix' approach, with the acronym '*MIDICCI*' (meaning smart woman in Malayalam language), recognizes the stellar role played by women in ensuring livelihood security. This adaptation is in continuation of the work of Bhaskaran & Sreedaya (2013) on the new role of extension education in rationalizing the use of five capitals - natural, physical, financial, human & social - required for sustained development. The '*MIDICCI*' approach encompasses the GEP such as Multi-purpose extension provision (M), Intensification of cropping with diversification (I), Decentralized and participatory planning and implementation (D), IT/ICT/social and Hybrid media use for conscientisation campaigns (I), Capacity building for knowledge intensive farming (C), Convergence of programs and agencies (C) and Innovative institutions for social entrepreneurship development (I).

Conclusion

The above approach of Extension forms the framework for the Agricultural Technology Management Agency Plus (ATMA PLUS) program now being implemented intensively in the Kerala State with funding from both the Central and State governments.

The ATMA PLUS program offers the ideal platform for the forging of Public-People-Panchayath-Private-Partnerships for the single window delivery of extension and advisory services quintessential for the inclusive and equitable development of the marginalized communities.

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PRA/RRA-Techniques

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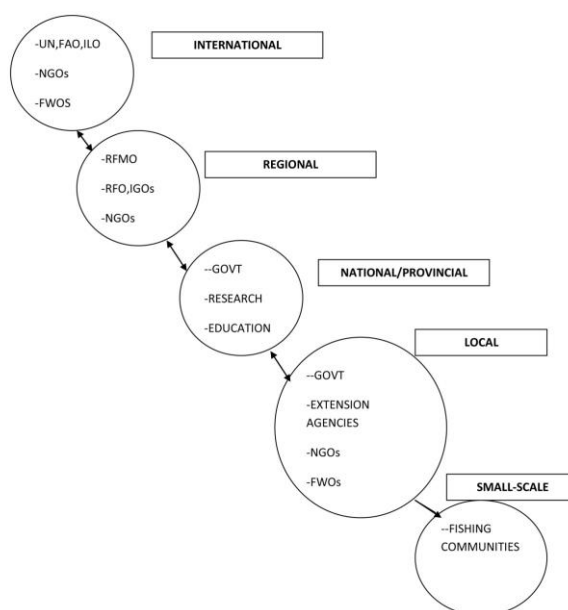
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Introduction:

Information and Communication Technologies

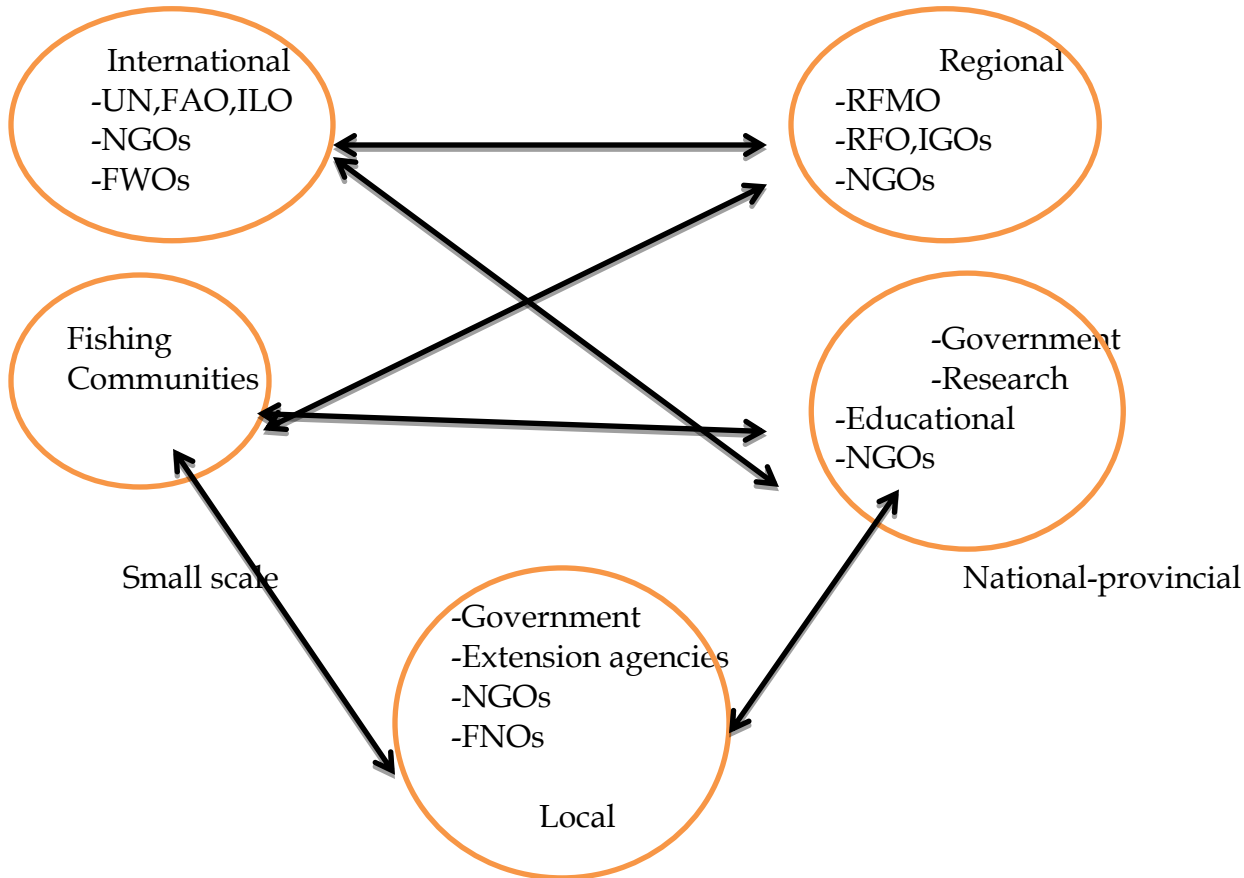
ICTs are technologies that facilitate communication and the processing and transmission of information by electronic means. This definition encompasses the full range of ICTs from radio and television to telephones, computers and the internet.

Figure 1. Current Information flow



The flow of information becomes more linear as it approaches the resource users, particularly in the small scale sector. The dotted lines indicate a less frequent and less effective flow of information

Figure 2. Required information and Knowledge flow



The various state holder categories should force a part of a network, within which smaller, more specialized or focused networks already operate.

Fisheries Management Practices and the flow of information.

The way the fisheries are managed and the participation by different state holder groups has implications for information provides as well as management decision makers. The recent developments in fisheries management have revolved around the ideas of decentralization, devolution, regionalization & participation. The code emphasizes a participatory approach including consultation among state holders and the effective participation of industry representative fish workers in decision making processes & in policy formulation and implementation.

Characteristics of fisheries Information:

1. Fisheries information is broad by multidisciplinary

2. It has depth in terms of time and perspective older information is valuable and more essential for effective fisheries management
3. It involves various scales from very local to global. The local has to be integrated with the global as fisheries resources are shared across space and time
4. It comes from a complex mix of sources information from different sources and disciplines may be at times contradictory.

New information and communication technologies (ICTs) are being used across the fisheries sector from resource assessment, Capture a culture to processing and commercialization. Some are specialist applications such as sonar for locating fish others include the global positioning system (GPS) used for navigation, location finding, mobile phones for trading, radio programming with fishing communities and web – based information & networking resources. These wide ranges of technologies can be adapted and introduced in the remotest of rural communities leading to a positive impact on their lives.

ICTs are thus defined as technologies that facilitate communication and the processing and transmission of information by electronic means
Responsible use of ICTs can contribute constructively to livelihood enhancement and poverty reduction in fishing communities

Access to and exchange of key information can assist fishing communities in making informed decisions on a variety of matters from whether to engage in specific fishing operations to trading at a local market to participate in a meeting.

ICTs can also assist people to be heard encourage networking, knowledge sharing and increase access to the governance process and political agency.

Flow ever there are concerns that marginalized and vulnerable communities may not benefit equally and that ICTs can contribute to widen the gap between rich and poor the powerful and exploited. Functional literacy may be needed for many digital technologies, which in turn requires new skills and capabilities.

In the long run, raising demand, falling equipment prices, growing integration and interconnectivity of ICTs suggests the spread of these technologies.

Keeping in view, the enormous potential of ICTs, it is argued that there is argued that there is an agent need for ensuring that

- The exploitation and spread of new technologies in fisheries is oriented towards meeting the needs of the poor
- Use of new technologies in fisheries in integrated into participative, people Centered Communications for development and knowledge sharing approaches.

Electronic technologies used in fishing operations

- Used as navigational aids and satellite enable communication systems such as GPS to mark fishing spots for easy return, saving time and fuel.
- Once on fishing grounds, sonar and echo sounders can be employed to locate specific shoals of fish

At present, sonar- based “fish finders” are getting cheaper, with local NGOs and fishing associations promoting their use for small scale fisheries, They can be installed in Telecentres-eg the one at M.S Swaminathan Research Foundation Pilot at Veerampattinam, Pondicherry, South India.

Key ICTs are:

1. Community or loudspeaker radio- price information received by the radio station or researched via specialist websites at the local telecaster is passed on to the community through established communication channels.
2. Mobile phone- providing there is network coverage, fishers, buyers and merchants communicate through voice calls, via SMS messages, Catch can be sold, while out at sea, buyers and processors can be informed of catch details before landing.

Abraham (2007) in his study on mobile phones in the fishing industry in India has found out that the fishing community in the southwestern state of Kerala has adopted mobile phones in large numbers. Using mobile phones at quickly to market demand and prevent unnecessary wastage of Catch – a common occurrence before the adoption of phones.

At the marketing end, mobile phones help Co-ordinate supply and demand and merchant can take advantage of the free flow of information on price to catcher to demand in undersupplied markets.

Fishermen spend less time idling on shore and at sea, whereas owners and agents go to the landing centers only when they receive information via mobile phone that their boats are about to dark.

Reference: Reuben, Abraham (2007) Mobile phone and Economic development: Evidence from the fishing industry in India Information Technologies and International development Volume 4, Number 1, 5-17.

Wastage in fisheries sector in India has been reduced from 5-8% of total catch to lose to zero and increased average profitability by around 8 percent (Jensen, 2007)

Initiatives in the Fisher sector

ATIC- Agri Technology Information Centre acts as a single window system with an objective to help farmers and other state holders to provide solution to fish farmers and farmers, fishermen and fisherwomen.

Kisan call Centre: The department of agriculture & Co-operation Ministry & Agriculture, Government of India has launched Kisan Call Centre across the country to deliver extension services to the farming community. A Kisan call Centre across the country to deliver extension services to the farming community. A Kisan Call Centre consists of a complex of telecommunication infrastructure computer support and human resources organized to respond to the queries raised by farmers in their local language.

Form school on all India Radio:

Radio has been used extensively as a educational medium in developing countries. Each broadcast ends with few questions to encourage participation and the audience are asked to send in replies with in a weeks time. All India radio Cuttack recently broad casted 11 lessons related to aquaculture

Aqua choupal:

Unique web based initiative offers the farmers of Andhra Pradesh all information on products, Services, need to enhance productivity, improve farm gate price realization and cut transaction cost Farmers can allers the latest local and global information in weather, scientific farming practices and market prices at village itself through a web portal all in Telegu. It facilitates supply of high quality form inputs as well as purchase of shrimps at their doorstep.

Information Villages:

Was set up by Mr.Swaminathan foundation in 1998 in 10 villages in Pondicherry. The project includes local language content and wireless internet access. It also provides relevant information regarding fish density in the ocean to the fishing communities.

Village Knowledge Centers:

In the wale of the Tsunami in 2004, village knowledge centers have been widely set up in major Coastal villages of selected districts. The knowledge centers are run by local self-help groups NGOs and villages to knowledge based livelihoods and creates income avenues for rural people, farming communities and disadvantages people.

Use of PRA and RRA in Responsible Fisheries Management

PRA and RRA (Participatory Rural Appraisal and Rapid Rural Appraisal) methods are new being used in Responsible Fisheries Management.

In the Bang Saphan Bay pilot project, in Thailand implemented by the Department of fisheries, the PRA method was used as an interactive data collection method, for the fishers

to ask about where, when and how they fish with different types of fishing gear and the kind of species they catch.

The local fishers knowledge collected through PRA is systemized into a Geographical information system (GIS), using relevant software (eg grass)

The knowledge base covers areas where they find resource species, location of fishing areas, used by different types of fishing gear and the overlapping use of resources by fishers from different villages

Eg: Preparations of resource maps by PRA method was followed by the local fishers'. It was effective in identifying, locating and classifying the resource occurrence distribution, tenure, access and areas where illegal fishing is done can be identifying in this manner.

HISTORY OF RURAL APPRAISAL AND RELAXED RURAL APPRAISAL

It was the late 1970s when rapid rural appraisal came to lime light. There was an urge among the rural development professionals to find out new methods, ways and means for understanding rural situation, way of living of the villagers, problems of rural folk etc.

Workshops

The workshop on 'rural development tourism' organized by Institute of Development Studies, which comes under the umbrella of Sussex University at Brighton in United Kingdom, in 1977 paved the way for outsiders (Rural development officials, extension workers, administrators, scientists, students, teachers and others) to think about alternative methodologies for knowing about rural life and conditions. Subsequent workshops like 'Indigenous technical knowledge workshop, conducted in 1978, the two workshops organized under the 'Rapid Rural Appraisal itself' in the same year (1978) and the next year (1979) at the same institute (Institute of Development Studies) made further emphasis for the need for methodological change of studying the rural life.

The six origins of Rapid rural Appraisal

Literature indicates that there were six origins for the birth of rapid rural appraisal (RRA).

They are:

1. Need for better information
2. We- the problems- they - solution
3. Obsolete experience of senior (male) officials
4. Antipoverty bias
5. Disillusion with survey slavery
6. Indigenous technical knowledge

1. **Need for better information:** Because of a variety of technologies pouring into villages from different fields of science like agriculture, health. Sanitation, engineering, etc., there

was fast and accelerating change in rural areas. This had developed curiosity and interest among the rural development professionals to find out and search for good quality and timely information which could give better insights and in-depth knowledge about the rural life, situations and conditions.

2. **We- the problem, 'they'-solutions:** There was a growing realization among the rural development professional (agricultural scientists, extensionists, administration, research scholars, rural sociologist, rural health practitioners, rural engineers, students and scholars planners, philanthropists and altruists) that there was something wrong in us-in knowledge, skill and attitude towards rural development which are the real problems and impediments for rural development. They- villages, have been living with the problems, managing their problems with little outside help, but with their own knowledge which should be considered as real solutions for problems in villages.
3. **Obsolete experience of senior (male) officials:** Senior officials, by virtue of their seniority, thought that they knew more about the conditions existing in villages, though they might not have visited the rural areas in the recent past. But. Slowly, they started realizing that their experience was obsolete (out dated). They also realized that their experiences were isolated ones which could not be generalized for all rural situations and conditions. The seniors were insulated from knowing the realities by virtue of their supervisory and administrative work which hardly permitted them to know the realities existing in rural areas. Most of the officials were all men and at helm of affairs and they rarely found time to understand the situation by going through the lengthy and voluminous reports about the studies made in rural areas. All these made them think of alternative methods to understand rural situations.
4. **Anti- poverty biases:** This refers to the dissatisfaction with the biases, with special reference
To quick and short visit to villages by the rural development experts and officials of development departments whose offices and residences are located in urban areas. This type of short visit to rural area by urban based rural development professionals is called rural development tourism, according to Chambers, et al. (1989). It was quite likely that antipoverty biases could join together which would result in the worst poverty and deprivation not coming to limelight, but hidden.
5. **Disillusion with survey schedules and their results:** Another factor which could be considered as the second origin of Rapid Rural Appraisal was the disillusion with routine way of conducting village surveys with the help of survey schedules and their results. In the past (and even today), in many organizations, academic institutions, and universities, village surveys took a lot of time to complete and were boring both to the interviewee (villager) and interviewer (rural development researcher).

Finally, these village surveys did not give any result and served no purpose either to the farmer or development departments. This has been thoroughly discussed by Moris (1970) in his paper entitled 'Multi-subject farm surveys reconsidered: some methodological lessons' which he presented in an economics conference in East Africa.

In the words of Moris (1970) and Chambers (1992):

Again and again, over many years and in many places, the experience had been that questionnaire surveys tended to be long drawn out, a headache to administer, a nightmare to process, and write up, in accurate and unreliable in data obtained, loading to reports, if any, which were long, late, boring, misleading and difficult to use any way, ignored.

Thus, the difficulties experiences with and the poor impact of village survey schedules made all concerned think of alternative methodology to understand the rural situations and conditions which resulted in emergence of Rapid Rural Appraisal Methodologies.

6. **Indigenous Technical knowledge:** The sixth origin for the birth of Rapid Rural appraisal techniques was recognition by the rural development professionals of the bitter truth that villagers were highly knowledgeable regarding many things, closely related to their day-to-day life and occupation. Development professionals started searching for simple, but cost effective technology or indigenous technology. According to Institute of Development Studies (1979) and Brokensha, Warren and Warrer (1980), the indigenous technological knowledge was increasingly seen to have richness in a high value for practical purposes. The problem faced by development workers and professionals was the non- availability of a clear cut, simple procedure to elicit the required information about ITK which could be used by others for the purpose of analysis of ITK for its future use by farmers of other areas, extension workers and scientists.

Alternative to survey methods invented,,: but not publicized

There are claims (Chambers, 1992) that alternative methodologies to survey methods did find their entry in the invention-box in late 1970s, due to the efforts of intelligent rural development professionals, but were not published due to the fear of what is called 'professional credibility'. For example, Collinson (1981) had developed one week-methodology to identify agriculture research priorities, but he had to use again a formal verification survey to convince the conservative bosses whom he calls "Establishment". With the result, the process became costly with delayed decisions and actions.

RRA ACCEPTED IN 1980s

Because of continuous and untiring efforts of rural development professionals and extension experts in finding out alternative methodologies for rural - schedule based survey techniques, Rapid Rural Appraisal technique as a family of approaches and methods emerged, in 1980s, to understand rural life and conditions. It was readily accepted and was viewed as if it had its own principles and rigour (Belshaw 1981: Carruthers and chambers 1981). RRA was argues to be cost effective for gaining timely information and insights which could be hardly obtained by survey-schedule tool. RRA was cost effective, had validity and reliability compared to survey techniques. But RRA based data would attain these qualities when it was not rushed, but, carried out with a self-critical attitude. In many

contexts and for many purposes, RRA, when well done, showed itself to be not a second-best, but, a best.

RRA Pioneers:

There were many countries, individuals and institutions who could be considered as pioneers in establishing the methods and principles of RRA. The table here indicates the number of countries which used RRA in the earlier years.

Table 1- Countries which used RRA in the earlier years

S.No.	Continent	Number of Countries
1	Africa	12
2	South and East Asia	8
3	Latin America	3
4	Australia and Pacific	3
5	Europe	1

RRA:From Rapid to Relaxed Appraisal

The word 'rapid' in Rapid Rural Appraisal has given the Impression that the appraisal should be done with great speed which has resulted in criticizing the method itself. The word 'Rapid' makes RRA practitioner to do rushing during the appraisal.

The word 'rapid' might have been a necessity in 1970s and in 1980s to differentiate it from the time consuming survey approach where the survey-researcher could collect data from two or at the most 3 farmers in a day whereas the entire rapid rural appraisal just takes a week's time to complete data collection in a village. But, the word 'rapid', has become a liability. There are evidence to indicate that 'Rapid Rural Appraisal', just because of the presence of the word 'rapid' in the methodology has been misused to legitimize brash and biased rural development tourism. The important rationale for RRA has been that one should make time to find the poorest to learn from them and to empower them. But, hurry and lack of commitment may lead to compound errors. Being hurry, the RRA practitioner may not find time to search for the poorest of the poor in the village. With the result, the poorest are once again, ignored, not met, not heard, and not listened to: neither the RRA practitioner learns from the poor. This means that the very purpose, i.e. to avoid antipoverty biases, for which RRA came into being is lost, and the devil of rural development tourism takes its life again. Hence, as Chambers (1992) has suggested, 'R' of RRA stands better for 'relaxed' (and not for rapid) allowing plenty of time.

Table 2: Contribution of Individuals and Organizations for the growth of RRA

S.No	Year	Organizations/Individuals	Work done
1	Mid 1980s	Khon Kaen University Thailand (K.K.U.)	<ol style="list-style-type: none"> 1. Developed RRA theory and Methods 2. Introduced multidisciplinary team Approach 3. Institutionalization of RRA as a part of professional training.
2	1985	-do-	<ol style="list-style-type: none"> 1. International Conference on RRA 2. Publication of a volume of papers a land mark
3	1987	Beebe	<ol style="list-style-type: none"> 1. Confirmation of practical value of RRA 2. Outlining the underlining theory of RRA
4	1987	Gibbs	
5	1987	Grand staff and Grand staff	
6	1987	Jamieson	
7	Later 1980s	International Institute for Environment and Development, London	<ol style="list-style-type: none"> 1. Dissemination of RRA principles through an informal publication of RRA Notes (1988-1989) 2. Dissemination of RRA through Extensive training 3. Working with African and Asian Colleagues
Health and Nutrition			
8	1987	Scirmshaw and hurtado	<ol style="list-style-type: none"> 1. Parallel and overlapping developments in specialized fields 2. Rapid Assessment procedure in 20 countries
Agriculture			
9	1985	Potten	RRA in Irrigation
10	1989	Greenfeldt	RRA in Irrigation

RRA continues

Thus RRA emerged in 1970s. It still, is a powerful tool for outsiders to learn and understand the rural conditions and situations. It enables the outsiders to gain information and insight from rural people and about rural conditions in a more cost effective and timely manner. It is less exploitative than extractive survey technique where much is taken by the

outsiders and little or nothing is given back. RRA is extractive or neutrally elicitive (Chambers.1992).

Participatory rural appraisal (PRA): Participatory learning and action (PLA)

The usual method of understanding the villages and villagers and village conditions by survey techniques with the help of schedule and questionnaire now a days has a counter by an alternative techniques called Participatory Rural Appraisal which is the off spring of a technique called Rapid Rural Appraisal.

While dissemination of rapid rural appraisal was in 1980s (originally it came in 1970) the participatory rural appraisal dissemination was in 1990s.

PRA emerged as an answer to the criticism biases of rural development tourism and questionnaire survey methods. RPA emerged as an answer to the criticism biases of rural development tourism and questionnaire survey methods. RRA slowly gave birth to PRA. They are synonyms in some respects. They owe much to the experiences: new lights and approaches of social anthropology, farming systems research, agro ecosystem analysis and activist participatory research where the basic principle is that local people should be able to do their own analysis.

PRA has been described in many ways: 1) a set of tools 2) an approach and 3) as an ideology.

It is a reverse flow from practice to theory rather than theory to practice.

Definitions of PRA

There is no dearth of definitions of PRA. It has been defined in umpteen numbers of ways by different scholars concerned with PRA directly or indirectly. Some of the definitions are given below:

- I. PRA maximizes possibilities, helps in placing intervention activities with the community value system and is effective in addressing the goals of cross-cultural understanding (Fussel, 1990).
- II. Participatory Rural Appraisal is a way of learning from, and with, community members to investigate, analyse and evaluate constraints and opportunities and make informed and timely decisions regarding development projects. By PRA, one can quickly and systematically collect information for
 - 1) The general analysis of a specific topic, question or problems.
 - 2) Needs assessment
 - 3) Feasibility studies:
 - 4) Identifying and prioritizing projects:
 - 5) Project or programme evaluation:

PRA is applied most effectively in relatively homogenous rural communities, which share common knowledge, values, and beliefs. Short duration and low cost nature of PRA make it possible carry out a series of PRA rather than having to rely on the result of one large survey. PRA is an intensive, systematic but semi structured learning experience carried out in a community by a multi-disciplinary team, which includes community members (Theis and Grady, 1991).

- III. Chambers (1992) defined Participatory Rural Appraisal has a growing family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions to plan and to act. Evidence to date shows high validity and reliability in information shared rural people through PRA. (Chambers, 1992).
- IV. Participatory Rural Appraisal aims at any enabling the rural people in analyzing their past, examining their present and envisaging their future by assessing their socio economic and geographic situation, identifying their problems, exploring their locally available resources, hammering out feasible solutions and formulating and action plans realizable during a certain time span (Narayana swamy and Boraian, 1993). "In the whole of PRA exercise, the local people constitute the actors as well as the audience and the outsiders serve merely as observers and, at times, as facilitators, but seldom as intervenors or interrupters" Narayanaswamy and Boraian (1993) added.
- V. Though many PRA techniques are simple, there are some which are complex to implement, requiring concentration, organization, and full participation. One can get best results of PRA then they are used flexibly and in sequence (Kate 1994).
- VI. PRA is a technique of increasing the capacities of the local people because it 1) enables the local people to collect information assess its relevance, to cross check its validity and documents and present the findings, to prepare project proposals 2) enhances capabilities to prepare project proposals (planning, management) and 3) improve local skills for dealing with potential conflicts between different interest groups (Richards, 1994).
- VII. The significance of PRA data collection techniques is that local communities potentially gain greater access to and control over the process of understanding and analyzing themselves in which development workers are engaged. This is a welcome departure from more 'extractive' forms of data collection which historically have disempowered communities (Watson and Cultis, 1994).
- VIII. Participatory rural appraisal is a well-defined and practical set of tools and techniques which if applied skillfully contribute to the process of empowerment and enhance the quality and validity of the information, (Grosse link and Strosser, 1995).
- IX. Participatory Rural Appraisal provides a creative approach to information sharing and a challenging to prevailing biases and preconceptions about rural peoples knowledge. Advocates of this approach argue that the production and the generation of potential solutions should be devolved on

to those whose livelihood strategies from the subject for research (Anonymous,1996).

- X. PRA techniques offer a variety of methods ranging from field based visualization, to interviewing and group work. They promote interacting learning, shared knowledge ,and flexible,but,at structured analysis.These methods have proven valuable for understanding local perceptions of the functional value of resources ,processes of agricultural innovations and social and institutional relations (PLA Notes,1996).

Early And Relaxed Rapport Building for Initiating PRA

The most important training for successful conduct and fruitful results of PRA is rapport building by the rural department professionals (outsiders like extension workers, scientists, administrators, researches, students and scholars) in the beginning of PRA activity .Rapport building facilitates acting participation of rural people in PRA. This has to be slow, steady and relaxed.

One of the principles suggested by Chambers (1992) to build early rapport is transparent honesty of the PRA practitioners telling the rural people who the PRA practitioner are. "Tell them what you are doing, what you are trying to learn". Chambers (1992) adds.

To build relaxed rapport with rural people

- (1) One should show:
 - a) Simlicity in appearance
 - b) Humility
 - c) Respect
 - d) Patience and
 - e) Interest in what villagers say and show.
- (2) The PRA practioner has to wander around the village rather than making flying visit.
- (3) The PRA practitioner should pay attention, what the villagers discuss.
- (4) He or she should give a patient hearing of what villages complain.
- (5) He or she has to watch what the villagers show.
- (6) The villagers should not be interrupted when he is seriously telling or explaining some problem in the village.
- (7) An analysis of PRA definitions reveal the following point:
 - a) A good tool for cross – cultural understanding.
 - b) A learning experience to know constraints opportunities of approaches.
 - c) A family of approaches
 - d) Local people analyse their knowledge and condition for planning and acting on the plans
 - e) Flexible and sequential applications give good results. Preparation of realistic plans

- f) The outsiders play the role of facilitators
- g) Intensive, systematic, semi-structured learning experience
- h) Analysing the past, present and future problems, resources, and solutions of people
- i) Local people analyse and understand themselves
- j) A process of empowerment
- k) The quality and validity of information is enhanced
- l) As the concentration is on livelihood strategies of rural people, involvement of rural people in knowledge production and potential solution generation is a must.
- m) It involves interactive learning knowledge sharing
- n) Flexible but yet structure analysis
- o) Most effective in homogenous rural communities
- p) Short duration and low cost in nature
- q) Many are simple but a few are complex and hence require concentration, organization and full participation of local people.

A PRA practitioner can get maximum benefit out of a Participatory Rural Appraisal provided he/she has favourable attitude towards the following:

- 1) Participation of the local people in the appraisal process.
- 2) The principle of 'give respect and get respect' with special reference to villagers.
- 3) Genuine appreciation and interest in what the villagers do and practice, have and know, talk and preach, indicate and show.
- 4) Willing to learn, having patience, being relaxed and not rushing, interrupting:
- 5) Real interest in listening and not in interrupting:
- 6) Not lecturing and talking too much without realizing the reaction of the person to whom one is talking.
- 7) Humbleness and
- 8) The ways and means by which the villagers can be empowered to indicate, increase, exchange and assess their knowledge.

A comprehensive definition of PRA

PRA is a flexible, low cost and time saving, set or family of approaches and methods used to enable the rural people to collect and analyse information in terms of the past, present and future situations to understand about the rural people and the conditions existing in rural areas which would provide a thorough and comprehensive idea regarding problems, potentials, resources and solutions to formulate realistic development programmes, by the villagers themselves but facilitated by PRA practitioners, feasible to achieve within a specific period of time by the villagers of a rural locality or to use the information and analysis by researchers to formulate need based research programmes to solve the problems of rural people.

PRA to PLA: The PRA has been called as Participatory Learning Action now a days. Here local people and outsiders actively participate in assessing the rural situation during which time both learn quite a lot which will help them to prepare a meaningful plan to put into action. Hence, Participatory Rural Appraisal (PRA) has been renamed as



Nomenclature of Rural Appraisal

Comparison of RRA and PRA

Though much of the activities remain common for rapid rural appraisal and participatory rural appraisal, in the words of Chambers (1997), RRA developed into PRA, and they are interchangeable in some respects. They have been made possible by new insights and approaches to social anthropology, farming systems research. Agro-Eco-System analysis and farms of activist participatory research. Based on literature review (Chambers, 1992 and Goss link and Strosser, 1995) and actual experience in field situation, the following eighteen points could be taken into account for comparing RRA and PRA period development, base of innovation, user difference, resources over looked, major innovations, mode, ideal objectives, long term outcome, outsiders role, owing, analyzing and using of information, checklist, scope for innovation, nature of participation of local people, involvement of local people and difference in end product.

Table : 3 Comparison of Rapid Rural Appraisal and Participatory Rural Appraisal

S.No.	Items	RRA	PRA
1	Period of major developments	Late 1970 and 1980s	Late 1980s and 1990s
2	Major innovation based in	Universities and Research Organizations	Non- government Organizations
3	Main users	Aides agencies and Universities	Non-government organizations & government field organizations
4	Main resources earlier overlooked	Knowledge of local people	Capabilities of local people
5	Main innovations	Methods	Behaviour

6	Predominant Mode	Elective and extractive	Facilitating and participatory
7	Ideal objectives	Learning by outsiders	Empowerment of local people
8	Long term outcome	Plan, projects and publications	Sustainable local action and institutions
9	Role of outsiders	Everything is done by outsiders like development officials extension workers research scholars, students, administrators, non-government organizations, foreigners, etc	Everything is done by local people. Outsiders are only conveners, facilitators. Catalysts and learners
10	Information owned, analysed and use by	Outsiders	Local people
11	Checklist	A 'must' for effective RRA	A 'must' for every PRA technique
12	Rapport building	A 'must for effective RRA	A 'must for every PRA
13	Difference in content	Content is same for every technique as in PRA	Content is same for every technique as in RRA.
14	Cross checking of data	To be done using triangulation principle	To be done using triangulation principle
15	Scope for innovation of new techniques	High	High
16	Nature of participation of local people	Passive- local people do not have much say in the various stages of appraisal process	Interactive – people participate at every stage of appraisal joint data collection, joint analysis, joint action plan
17	Involvement of local people	Low	High
18	Difference in end product	No difference in comparison to the end product of PRA and RRA. Ex. Social map same as that of PRA social map	No difference in comparison to the end product of RRA. Ex. Social map same as that of RRA social map.

Thus, much of the characteristics are common for RRA and PRA except for a few characteristics which differentiate these two approaches.

Participatory Methods

Important participatory methods used in field situations for probing relationship of local communities with natural resources are described here. The illustrations which accompany the methods and applications relating to PRA & P ANR from the field. The major methods are as follows.

- A. Semi-structured interviews
- B. Time line
- C. Participatory mapping
- D. Identification of groups
 - 1. Asking key informants
 - 2. Wealth ranking/grouping
 - 3. Venn diagramming
 - 4. Participatory social mapping
 - 5. Social matrix method
- E. Venn or "Chapatti" diagram
- F. Joint walk
- G. Vector scoring
- H. Matrix scoring
- I. Participatory seasonality analysis
- J. Trend -analysis
- K Source diagram
- L. Flow chart

These are explained briefly in the text and further high-lighted in the appendix with concrete examples from the field. These examples are self explanatory. But the readers may fill up with information collected from his own field work area.

A. Semi-structured interview

Semi-structured interview is mainly based on open questions. In this method of participation there is a great deal of flexibility. The open questions lead to different kinds of responses based on which further questions are designed on the spot for probing of issues. A sequence of open questions help in conducting an in-depth probing of issues and their cause effect relationship.

Before the beginning of an interview, the interviewer must have a small checklist of issues on which questions can be asked. Once an interview starts, other relevant issues can be added to the checklists. This will help in enriching discussion of a theme by moving from

one aspect to another. It is always better to have a team including a member from each discipline for conducting the interview. It helps in probing the issues from different angles. For eliciting responses on various issues, questions may be framed based on six words i.e. why, how when, where, who, and what questions asked during the interview and respective responses from community member should be noted down. It is better to have the inter-viewer and the recorder different persons. From the side of an interviewer impatience and interruptions need to be minimized so as not to block or disturb the processes of community analysis. The interviewer should have capacity to judge the behavior and attitude of community members. If he feels that members are not taking interest in answering the questions, interview should be postponed.

B. Time line

Degradation of natural resources is an age old phenomenon, associated with the community development. It is important to know the historical profile of natural resources and their relationship with people. Time line is a major participatory method which can be used in probing of this relationship. The major issues in probing may include historical impact of resource degradation, community efforts to preserve natural resources, impact on livelihood changing habits, food pattern, quality of life etc. Any analysis of event remains incomplete without proper understanding of its past context.

In order to construct a time-line one should sit with elderly people in a community. These people will trace historical patterns of change in their locality and community. They may not be able to trace the exact time, date or year. But they will connect some major historical event whether political, economic or social.

Time line is the best participatory method to collect information pertaining to changes in forests, land use, community preferences, community problems, socio-economic aspects, bio-diversity and other developmental activities. Historical narration of events, their impact and changes can differ from one informant to other depending on their perceptions. It is useful to keep track of the broad time period to which they refer to rather than looking for specific data. From a time line important changes or events may be selected for further probing.

C. Participatory mapping

Participatory mapping is a blue print of the area where local communities are living and from where they are earning their livelihood. It includes details and locations of house-holds, livestock, farm size, water bodies, field, forest, trees, road, literacy, disease, etc. depending on the theme under discussion. There may be different maps for different theme such as resource map, social map, literacy map, etc.

In the process of participatory mapping, few (two or three) persons take lead in drawing the map. Other members of the community help them in cross checking the locations and details which are forgotten by leading persons. Different maps may be drawn by different group of the people. In the resource map details like forests, lands, fields, cultivated and barren, irrigated and un irrigated area, orchard, etc. may be depicted. Social

mapping may include households and other buildings in the area etc are also depicted. An example of the participatory resource map is given in Appendix II.

1. Others

Other areas which can be shown in participatory mapping are the following.

- a. For showing community habitat, forest land and their area,
- b. Households, trees, water bodies, soil, farms, hand pumps, schools and other things in the locality,
- c. Land use in a locality,
- d. Boundaries of locality and forests,
- e. Spatial areas of people-forest conflict cooperation,
- f. Grazing areas,
- g. Areas for social forestry,
- h. Common property resources (CPR) and wastelands,
- i. Areas for collection of fuel wood and
- j. Water bodies.

2. Significance

Participatory Mapping Method of PRA is having great significance. Some important points of significance are the following.

- a. On many occasions, mapping helps in rapport building with local communities. It helps an outsider to learn from a community and furthers mutual interaction.
- b. It involves local communities/ groups and empowers them to map, illustrate and explain their own locality.
- c. It enhances group participation especially when maps are drawn in open spaces and common meeting grounds.
- d. It helps in projecting spatial view of localities and related natural areas.
- e. Forest maps help in clarifying extent of accessibility of local communities of local forests.
- f. Mapping helps in cross checking by individuals and groups for errors and omissions.
- g. It helps in arriving at group consensus.
- h. It provides a basis for further probing undertaking joint walks and applying other methods.
- i. It helps in generating a wide variety of data in a relatively short period of time.
- j. It provides an overview and background material data important for probing into any relevant theme.

D. How to identify groups

Community is composed of many groups and sub-groups. Communities need not to be and are not socially homogenous. For smooth conduct of PRA, it is important to recognize the identity of groups and sub-groups. For identification of these groups' there are different way some of which are explained here.

1. Key informants

Key informants can be asked about socio-economic relationships and existing groups in a community. The groups which needs special attention are poorest of the poor, women, scheduled caste, scheduled tribes. Information provided by key informants can be cross checked by other sources.

2. Participatory social mapping

Participatory social mapping is another method which can indicate existence of different socio-economic groups in an area or community. Such mapping can be of significant use in identifying different social groups. There may be several groups depending on the social composition and control of resources in the village. In general groups may include poorest of the poor households as groups, house holds above the poor as group-2. House-holds above group-2, group-3 and households above group-3 as group-4.

3. Wealth ranking or grouping

Wealth ranking or grouping is another method which can be used for group identification. Wealth ranking helps in understanding socio-economic disparities amongst households and reveals local criteria for wealth classification.

4. Venn-diagramming

Venn-diagramming session on groups and their relationships helps in identifying groups. This method is explained below under heading 'E'. Venn diagram can be used as a tool to show the existence and importance of different groups in a community.

5. Social matrix

Social matrix is yet another method for identifying. groups and their characteristics. In a grid-like-set-up, different criteria of different groups can be listed by key informants, which can then be scored. This would provide a rough idea of the existence of different groups which may be cross checked further.

E. Venn or "Chappati Diagram"

Venn or Chappati Diagram is a visual method to represent the role of individuals or institution in the process of decision making. It also measures degree to which decision is influenced by the groups or individuals. Circles of different size representing different individuals institutions/groups show their importance in decision making. Such circles can be drawn on ground/paper, or alternatively, circular shaped papers of different size can be used for symbolizing such relationships. The distance of circles (diagram) indicate the relationship of individuals/ institutions/ groups which such circles represent Overlapping of circles indicate their over lapping in decision making.

For rural people in a village community Venn diagrams would reflect the kind of communication between them and the rest of the village community and their

governmental organizations and NGOs. Different aspects of their life can be taken up to see their interaction and their role in decision making involving village planning in running of projects, in distribution of land, credit, water and other assets and in construction of roads, school building, dams, etc.

E. Joint walk

In the method of joint walk villagers and project implementing agency members walk through a selected area. During walk, they discuss about different aspect of land-use and agro-ecological zones in the village. For example, a degraded forest area, identified through a map can be jointly surveyed by community members and outside agencies for discussion in terms of causes, nature and action for regenerating such forest area. The walk may be summarized as per land use describing soil conditions, trees, crops, animals, birds, kind of soil erosion, water sources, fodder species, problems and opportunities. Such joint walks involve detailed understanding of issues related to selected areas from local people. A sequence of such joint walks can be organized depending on locations in question. The areas for joint walk is generally selected in consultation with local community, either on the basis of group discussion, semi-structured interviews or on the basis of participatory mapping.

F. Vector scoring

Vector scoring is a visual method and involves scoring of criteria items for assessing their relative importance so as to prioritise problems/benefits/ dangers/ damages/ opportunities, etc. This method can be used by individuals as well as groups. At the beginning, the agency's team intervening with local community, generally take help of semi-structured interviews with groups of local people who generate different criteria item which they think are important for consideration by groups. Such criteria can be either a set of problems, a set of benefits, a set of preferences, a set of activities/ items etc. Such a list of criteria can be placed before the group members who are concerned with such scoring. They can make further deletion or addition to the list of criteria according to their views. Hence, the method of vector-scoring involves considerable flexibility in generating criteria and also flexibility in terms of scoring.

Once there is consensus on the list of criteria, it can be transferred to the ground, in a column. or a row, either on small pieces of paper or with the help of different indigenous symbols. It is important to have agreed symbols for representing criteria especially where group members are illiterate or semi-literate. This would empower them to understand each criterion on their own and think about it before scoring.

Scoring of the criteria may be done individually first and then in groups. It is essential to train the group members about rate of scoring. The individual scoring is just a thought provoking exercise. This also helps in warming up for group scoring. Individual scoring can be followed by group scoring. The individuals may be requested to perform group-scoring of criteria, either by falling into one group or in different small groups as per their preference. Much depends on how the community wishes to fall into groups. In any

case, it is important to encourage group interactions and discussions before group scoring takes place. An illustration of vector scoring is given in Appendix VI which shows scoring of a women group on benefit criteria from social forestry and flood protection measures in village Bhagwanpur Jullon near Dehradun. The women group used fixed scoring for 10 criteria. The most important criterion as per the women group was that of bank erosion getting stopped through embankment, which was considered to be the foremost benefit

Scoring by seeds, stones, pebbles or other indigenous material can indicate the relative importance of a criteria. Scoring of criteria can be free or fixed. In fixed scoring, a fixed number of scores say ten scores are used. So scoring is fixed in terms of the number of scores used and also shows relative importance of criteria. While free scoring has no limit on scores used for each criterion. Greater scoring indicates relatively greater significance of a criterion under consideration. Style of scoring much depends on choice and convenience of the local people.

Vector scoring strengthens base for prioritization and analysis of problems in a local community. It helps in arriving at ways to handle such problems. The output of the method when involving a small group for vector scoring can also be a basis for starting or strengthening appropriate actions in a community. Such output can be referred back to the community for additions and alterations and for resolving conflicts.

G. Matrix scoring

Matrix scoring is concerned with scoring of a range of criteria against a range of comparable items. For scoring items can be selected by local community members. They can be a set of trees, a set of animals, a set of crops or different varieties of the same crop, a set of cooking devices, a set of trees in a home garden, a set of vegetables, etc. Matrix scoring is a method of relative scoring of items in relation to a set of criteria. It is important that the criteria to be scored should be worthy of comparison and it should lead to some meaningful analysis. The scoring takes place in a grid like set-up, with items on one side and criteria on the other (Appendix VII). This can be treated as an extension of the method of vector scoring. The chart shows matrix scoring of wild trees. Appendix VIII utility scoring of minor forest produce by a village group where eleven tree species have been compared against eight utilities.

1. Participatory seasonality analysis

Seasons tend to influence lives and livelihoods of local communities. Hence, it is important to appreciate and learn about seasonality dimensions in lives of local people. The seasons bring changes in climate and rainfall, agro-ecological conditions, natural and extent of job availability, soil conditions, days of labour, wages, food patterns, disease vectors, disease incidence, income expenditure, consumption patterns etc.

In this method, the local people are asked to describe and compare their activities, livelihood patterns, food, debt, disease patterns, rainfall, etc. as per seasons and construct such seasonal calendars by using indigenous material. At first such seasonal changes are verbally described by them which can then be followed by visual illustrations by local people using indigenous materials.

Any seasonal analysis generally starts with a semi-structured interview on season and a discussion of their impact on community lives. It is generally convenient to start by a discussion of the prevailing season and then the other seasons tend to get included in the analysis. Once the purpose and nature of probing are made clear to local groups, they are asked either to explain verbally each season and its impact or illustrate seasonality, visually on the ground. This is illustrated in Appendix IX.

H. Trend analysis

Happenings of the history are described by the people in the method of trend analysis. Trend in ecological surroundings can also be demonstrated through this method. For instance the method can be used to show past trend in the number and density of trees, selected species of trees, water resources, bio-diversity etc. This method helps in providing a back ground to any issue through trend analysis. The community members can be requested to show such trend visually, preferably on the ground with indigenous materials such as sticks/seeds, stones, leaves etc. and then asked to explain such trend. For example the decrease in the number of trees year by year may shown in Appendix X.

I. Flow chart

In this method, the local people describe cause effect relationship, whether verbally or visually and explain linkages amongst different factors. Each problem would have its determinants as perceived by local communities and a flow chart can link problems with their perceived caused and help in arriving at possible solutions to such problems. Flow chart can give trends like years of crop failure, number of trees in a particular area, incidences and occurrences of pests and diseases etc.

J. Source diagram

This method helps in identifying sources of any activity, item, issue, etc. and also ranks such sources according to their importance. Like sources of fodder, fuel, food, fibre, etc. can be identified in village area and may be ranked.

V. Sequencing of PRA Methods

PRA methods can be used in different sequences for appraising different aspect of rural perceptions. Much depends on the objectives at hand, the kind of data required and the use to which the data would be put. One method leads to another depending on the topic being probed. A social map and wealth ranking can be followed by ~ joint walk in

those areas of the village where the poor people are concentrated in order to learn about their problems, opportunities and limitations. This can be followed by farm maps and livelihood analysis so as to know more about the crop grown and the soil conditions and the technology used by rural poor and the kind of livelihood they have. This can be followed by seasonality diagrams to have information about various related aspects. The sequence can take a couple of days depending on the convenience of the villagers, the rapport building and the facilitation skills of outsiders. Sequencing of PRA methods can help in appropriate interventions by state or NGOs through project formulation and planning.

Likewise there may be several sequence combinations of the PRA method, depending on the local situations and conditions. A resource map can be followed with a food calendar and a matrix scoring and ranking of wild trees. This can lead to placing of wild trees on the resource map so as to locate them in a village. In case of planning and implementing programs for poorest of the poor; the villagers can participate in wealth ranking to identify the groups involved. A social map can be drawn followed by wealth ranking so as to know the poor people, their assets and characteristics. The individual households of the poorest of the poor can be approached for their livelihood analysis and the kind of support they look for in terms of the program to be implemented.

Sequences can be both short and long. The length of the sequences would depend on the topic at hand, the willingness, energy and time of the villagers and the information generated. Some topics can take more time than others and can involve sequencing of several PRA method to reach the core. However, there can never be any hard and fast rule on sequencing since much depends on the situation at hand, the objectives of a PRA exercise and the way in which it takes shape. This is the novelty of PRA where it differs from situation to situation. It is a creative activity whose form and process are difficult to predict beforehand.

Conclusion

The process of rapport building, identification of key informants and different PRA methods are discussed in this booklet. Indigenous knowledge sources in rural areas can help the project implementing agencies in proper planning and implementation developmental programs. Local histories, stories, folklore, practice, beliefs, traditional management systems and village analysis can provide materials for having a better understanding of rural communities from diverse angles. Such sources can provide background information about a rural community in terms of its culture, socio-economic political and ecological trends. The PRA methods described in this booklet, include both indirect methods supportive of PRA and those that involve direct participation of rural people. Each method whether visual or verbal can be used in its own way to approach rural issues.

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Livelihood analysis –tools

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The history of livelihood analysis stems from the agroecosystem analysis developed by Conway (1985, 1986, and 1987) and Gypmantasiri et al (1980) at the University of Chiang Mai. They analysed the relative values of the villages in terms of bar diagrams of relative sources of income, expenditure pattern etc. (Chambers, 1992). The livelihood analysis is concerned with stability, crises and coping, relative income, expenditure, credit and debt. In reality, livelihood analysis analyses multiple activities (Chambers, 1992). Here the information is diagrammed to represent family size, income, indebtedness, crisis management of people belonging to different social classes of the society. The livelihood analysis can be done very well by the farmers under the active guidance of the facilitators as it has been proved in India and elsewhere.

Concept of livelihood analysis

Livelihood analysis refers to finding out the degree to which the pattern of life differs from one social class to another social class in terms of size of the family, type of house, technology adoption pattern, size of land holding, annual income, sources of income, food habits, expenditure pattern, indebtedness, type of animals owned, migrants in the household, seasonality of variation, crisis management pattern etc.

Livelihood Analysis Diagram

A diagram is a drawing or plan that uses simple lines rather than realistic details to explain or illustrate a structure, process etc. (Hornby, 1989).

A diagram is a simple schematic device which presents some information in a condensed and readily understandable visual form.

Livelihood analysis diagrams are used to help interpret the behaviour, decisions and coping strategies of households with different socio-economic characteristics. (Theis and Grady, 1991). Theis and Grady (1991), recommended the following variables for livelihood analysis of a village.

- 1) Household size and composition.
- 2) Number of labour migrants in the household.
- 3) Livestock and land ownership
- 4) Proportion of income by source.
- 5) Expenditures
- 6) Seasonality
- 7) Relative income
- 8) Credit and debt

Use of livelihood analysis:

Livelihood analysis is used for preparation of an efficient, practical and feasible action plan for the upliftment of the various sections of the rural society so as to make a socialistic pattern of rural society.

The livelihood analysis indicates the variation among the various classes with regard to many day to day phenomena. This can be taken into account in preparing the action plan. The action plan process can easily be broken down into various activities in a sequential way so as to achieve the ultimate objective of wholistic agricultural development.

This livelihood analysis indicates the various sources of income for different classes. This information can be used in selecting the beneficiaries for income augmenting rural, agricultural and animal husbandry schemes so that income level can be balanced among different social classes of a village.

The expenditure pattern data can be effectively used to promote educational campaigns so as to make the villagers spend money in a profitable way.

Variables to be chosen for livelihood analysis:

- 1) Type of house: whether concrete, tiled or thatched.
- 2) Size of the family: Number of family members under different categories like male, female, children, permanent labourers, members away from the home for months together etc.
- 3) Land holding: Area under wet land, garden land and dry land etc.
- 4) Nature of farming: Diversified farming or not.
- 5) Livestock ownership: Number of animals under different livestock species.

- 6) Annual income: The yearly average income in cash.
- 7) Sources of income: The various sources of income like crop production, livestock production, fisheries, sericulture etc.
- 8) Expenditure pattern: percentage of money spent for various items like cultivation, food, education, health, cloth, ceremonies, livestock management, etc.
- 9) Seasonal variation: Month in which income is more or expenditure is more for different expenditure items.
- 10) Savings: Nature of savings in cash or kind.
- 11) Debts: Loans taken from different financial institutions.
- 12) Crisis management: Major criteria and the waves and means of solving crises like crop failure, sudden illness of a family member, marriage, theft etc.
- 13) Food habits: Type of food, number of times food taken in a day.
- 14) Sources of food: From farm, from outside, purchased, gifts from friends and relatives.
- 15) Material possession: car, scooter, TV, Fridge, phone.
- 16) Education of children: Convent going, private, government school going etc.

Steps in Analysis of Livelihood:

The quality of the end product of livelihood analysis enhance when livelihood analysis is done systematically in a step by step manner.

Step I: The livelihood analysis should be carried for a village only after wealth ranking is completed. Hence, complete wealth ranking.

Step II: Choose one villager from each category of wealth categories of the village at random. It is better to choose a villager whose wealth score is around the mid-value of the score range for a wealth category.

Step III: Use the common criteria analysis of wealth ranking technique for livelihood analysis. Prepare relevant tables for collection of data.

Step IV: Use the variables for livelihood analysis for collection of data from the villager chosen for the particular wealth category to prepare relevant tables for data collection.

Step V: Prepare copies of livelihood analysis (L.A.) data table

Table 1 : Livelihood analysis data table

S.No	Variables for livelihood analysis	Head of households			
		1	2	3	4
1	Types of house: (a) Concrete (b) Tiled (c) Thatched				
2	Size of family: (a) Men (b) Women (c) Children (d) Migrants for months in number for Purpose: (a) Education (b) Labour (c) Job (d) Any other				
3	Land holding: (a) Wet land (b) Garden land (c) Dry land (d) Any other				
4	Nature of farming: (a) Crops alone (b) Mixed farming (Specify) (c) Any other				
5	Livestock: (a) Goats (b) Sheep (c) Buffaloes (d) Cattle (e) Any other				
6	Annual Income: In cash				
7	Source of Income (a) Livestock (b) Agriculture (c) Fish culture (d) Any other (specify)				

8	Expenditure pattern (Percentage of money spent) (a) Cultivation (b) Livestock management (c) Food (d) Education (e) Clothing (f) Medicine (g) House (h) Ceremonies, festivals (i) Any other (Specify)				
9	Seasonal variation in expenditure (a) Cultivation (b) Clothing (c) Education (d) Medicine (e) Any other				
10	Saving (1) Kind (2) Cash				
11	Debts (a) Loans in Amount (b) Source, Installments				
12	Crisis management (a) Nature of the crisis management, death, cyclone, drought, loss, theft and illness etc. Way of management (a) Loan (b) Sale of land or livestock (c) Any other (Specify)				
13	Food Habits. (1) Number of times food taken in a day (2) Nature of food.				
14	Source of food from (a) Farm (b) From relatives (c) From gifts (d) Any other (specify)				

15	Material possessed like Car, Scooter, T.V, fridge, Washing machine etc.				
16.	Education of children (a) Convent school or Govt. School (b) Any other (Specify)				

Step VI: Make copies of Livelihood Analysis (data table) and give one to each member of PRA team.

Step VII: Delegate the process of interviewing one village to one PRA team member to collect information on data table.

Step VIII: Let the team members collect the data from selected villages of each category.

Step IX: Selected another villager from each category and collect Livelihood analysis data

Step X: Apply triangulation principle through observation, talking to neighbor etc.

Step XI: Prepare livelihood analysis diagrams for each datum in the form of bar graphs, Pie charts, Pictorial graphs etc.

Step XII: Show diagrams to key informants for concurrence.

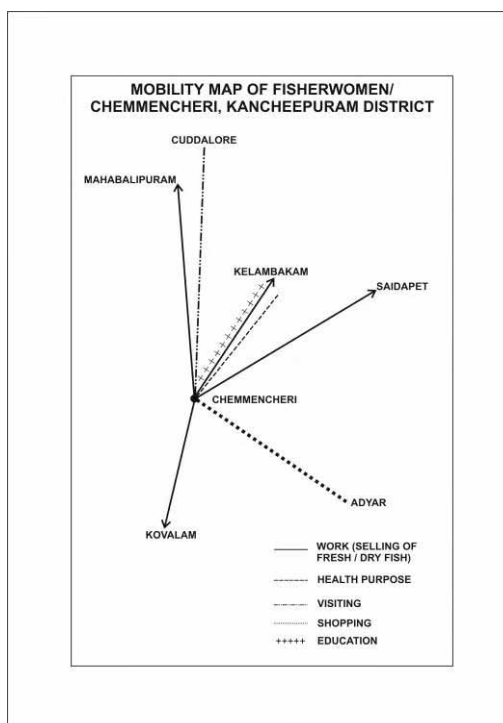
Step XIII: Show the diagram to the villager from whom the data were collected for concurrence.

Step XIV: Modify the diagram and tables if necessary as suggested by key informants and the concerned villages.

Step XV: Note down the names of villagers, from whom Livelihood Analysis data were obtained, just below the data table sheet concerned.

Step XVI: Note down the names of the PRA team members, who collected data for Livelihood analysis tables, at the bottom of the Livelihood Analysis table for authenticity. Indicate the date.

Step XVII: Use the livelihood analysis while preparing the action plan for village upliftment, beneficiary selection for different schemes etc

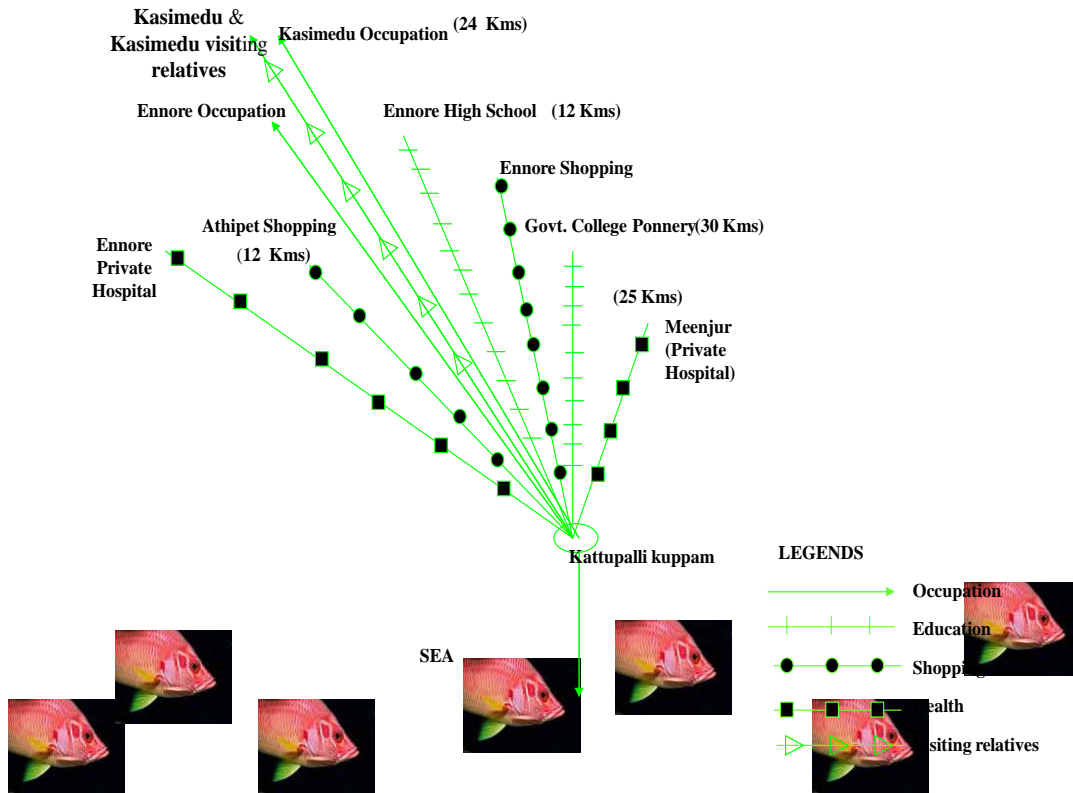


(SEASONALITY MAP)

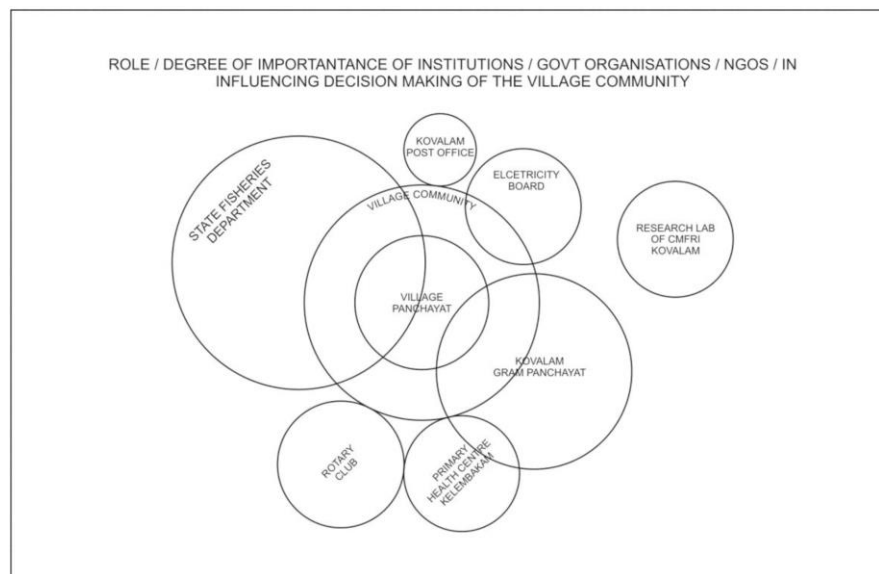
SPECIFIC MONTH WISE SHORE BASED OPERATIONS

S.	MONTHS	SHORE BASED OPERATIONS
1.	JANUARY	Maintenance of fibre boats, repairing of worn out bottoms of these boats and painting them
2.	JANUARY FEBRUARY -	Women get employment in Jelly fish sheds ("Sori" sheds). Trampling of the Jelly fish by feet to exude poison, treating it with chemicals, soaking them and then taken to export companies. Women are paid Rs. 80 for 10 hrs of work. It is a seasonal source of employment, whereby women get wages for 10-15 days during this month.
3.	MAY - JUNE	Dry fish making of sardines by women on a large scale. Women sell the dry fish in wholesale/retail markets at Kelambakkam @ Rs. 10.00/kg
4.	NOVEMBER	Stitching of shore seines (Periyavalai) for catching carangids, scombroroides and mackerel, and keeping them ready for the month of January, Periyavalai is stitched out of Cotton threads or "Pattu nool" and are long lasting.
5.	NOVEMBER DECEMBER -	Stitching of manivalai / eral nets (Prawn nets). Stitching of Mackerel nets/Tharavalai (100 knots width)

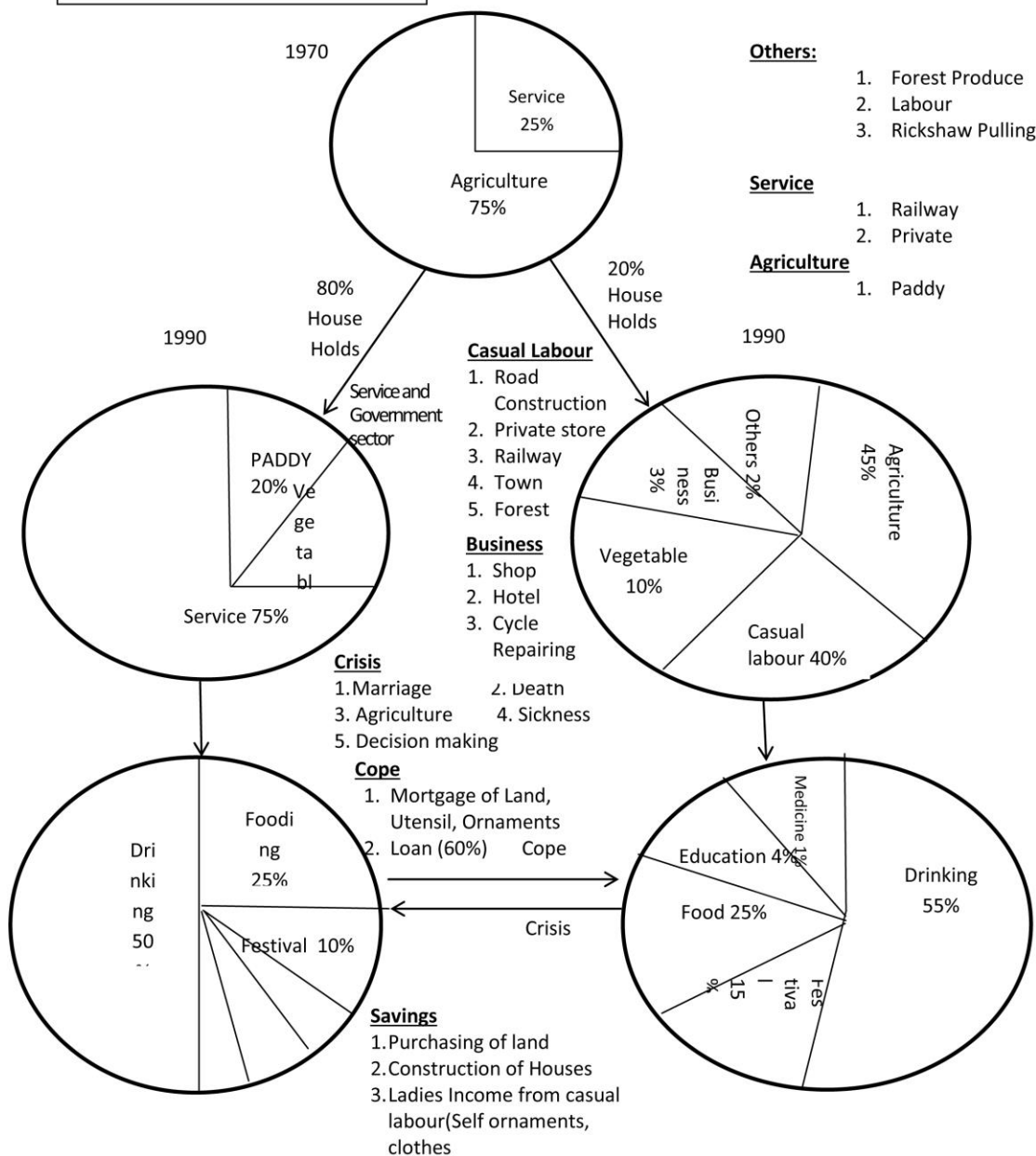
Mobility map for Kattupallikuppam

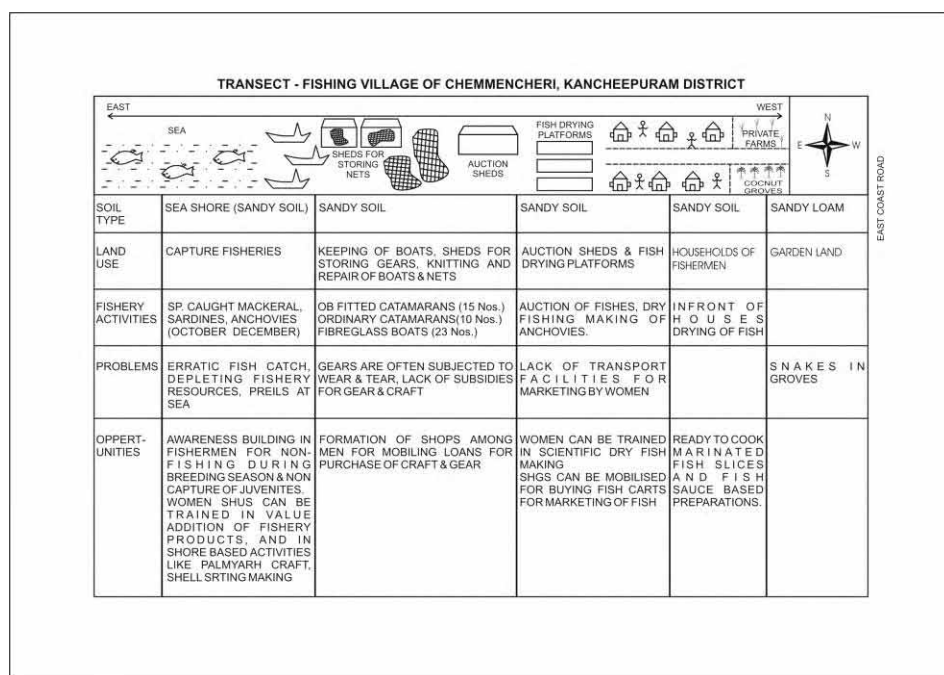


VENN DIAGRAM - CHEMMENCHERI VILLAGE



LIVELIHOOD DIAGRAM





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Global Legal Instruments and Regional Fisheries Management Organizations(RFMOs)

Sebastian Mathew

Global legal instruments of greater relevance to RFMOs

- 1982 United Nations Convention on the Law of the Sea (LOSC)
- 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas
- 1995 United Nations Fish Stocks Agreement (UNFSA)
- 1995 FAO Code of Conduct for Responsible Fisheries (CCRF)

Definition of RFMOs:

‘Intergovernmental fisheries organizations or arrangement, as appropriate, that has the competence to establish fishery conservation and management measures’ (IPOA-IUU)

Key subjects and issues of importance to RFBs include management of fisheries, the application of the ecosystem approach, the minimization of bycatch and IUU fishing, science and research, institutional/organization matters, application of the precautionary approach, and transparency in decision-making processes.

Three categories of regional fisheries bodies(RFBs) - in terms of institutional relationship with FAO:

- Established under FAO's Constitution – There are two types of RFBs in this category, those established based on Article VI of the FAO Constitution and those established based on Article XIV. The differences are mainly in terms of finance, mandate and autonomy whereby Article XIV bodies (APFIC, GFCM, IOTC, RECOFI and CACFish) are more autonomous than the Article VI bodies.

- Established outside the FAO framework but with FAO depositary functions – This means that the Director-General of FAO exercises depositary functions for organizations such as ICCAT, LVFO, SEAFO and SIOFA.
- Established outside FAO's framework – FAO closely monitors these RFBs due to their importance in global and regional fisheries governance. Such bodies include CCAMLR, CCSBT, NAFO, NEAFC, WCPFC and IATTC.

Many RFMOs are taking steps to strengthen governance through implementing the ecosystem approach to fisheries and adopting the precautionary approach. They are also working to strengthen international cooperation, promote transparency, address non-members, and enhance monitoring, control and surveillance (MCS) measures, including the implementation of mandatory vessel monitoring systems (VMS), the adoption of regional schemes for port State measures and the development of vessel lists.

There are 20 RFMOs listed below chronologically:

1. International Pacific Halibut Commission (IPHC) (1923)

Objectives and main functions

The main objective of the International Pacific Halibut Commission (IPHC) is the conservation and preservation of the halibut fishery of the Northern Pacific Ocean and Bering Sea.

The main functions of the IPHC are:

- to conduct and coordinate scientific studies relating to the halibut fishery and to formulate regulations designed to develop the stocks of halibut to those levels that permit optimum utilization;
- to submit regulations, mainly the total allowable catch of halibut in the Convention Area, to the two governments for approval. Upon approval, the regulations are implemented and enforced by the appropriate agencies of both governments.

Area of competence

The territorial waters and exclusive economic zones off the western coasts of the United States and Canada, including the Bering Sea.

IPHC area of competence - High seas, National waters

Species and stocks coverage

Pacific halibut (*Hippoglossus stenolepis*).

Members

Canada, United States of America.

2. International Whaling Commission (IWC) (1946)

Objectives

The main objective of the International Whaling Commission (IWC) is to establish a system of international regulations to ensure proper and effective conservation and management of whale stocks. These regulations must be "such as are necessary to carry out the objectives and purposes of the Convention and to provide for the conservation, development, and optimum utilization of whale resources; must be based on scientific findings; and must take into consideration the interests of the consumers of whale products and the whaling industry."

Area of competence

The area of competence of the IWC is global. The International Convention for the Regulation of Whaling also applies to factory ships, land stations, and whale catchers under the jurisdiction of the Contracting Governments and to all waters in which whaling is prosecuted by such factory ships, land stations, and whale catchers.

Species and stocks coverage

Blue whale (*Balaenoptera musculus*); bowhead whale (*Balaenamysticetus*); Bryde's whale (*Balaenoptera edeni*, *B. brydei*); fin whale (*Balaenoptera physalus*); gray whale (*Eschrichtius robustus*); humpback whale (*Megaptera novaeangliae*); minke whale (*Balaenoptera acutorostrata*, *B. bonaerensis*); pygmy right whale (*Caperea marginata*); right whale (*Eubalaena glacialis*, *E. australis*); sei whale (*Balaenoptera borealis*); Cuvier's beaked whale (*Ziphius cavirostris*); Shepherd's beaked whale (*Tasmacetus shepherdi*); bottlenose whale or Baird's beaked whale (*Berardius bairdii*); Arnoux's whale (*Berardius arnuxii*); southern bottlenose whale (*Hyperoodon planifrons*); northern bottlenose whale (*Hyperoodon ampullatus*); killer whale (*Orcinus orca*); long-finned pilot whale (*Globicephala melaleuca*); short-finned pilot whale (*Globicephala macrorhynchus*); sperm whale (*Physeter macrocephalus*).

Members

Antigua and Barbuda, Argentina, Australia, Austria, Belgium, Belize, Benin, Brazil, Bulgaria, Cambodia, Cameroon, Chile, China, Colombia, Republic of Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Eritrea, Estonia, Finland, France, Gabon, Gambia, Germany, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kenya, Kiribati, Lao People's Dem. Rep., Lithuania, Luxembourg, Mali, Marshall Islands, Mauritania, Mexico, Monaco, Mongolia, Morocco, Nauru, Netherlands, New Zealand, Nicaragua, Norway, Oman, Palau, Panama, Peru, Poland, Portugal, Republic of Korea, Romania, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Saint Vincent/Grenadines, San Marino, Senegal, Slovakia, Slovenia, Solomon Islands, South Africa, Spain, Suriname, Sweden, Switzerland, Togo, Tuvalu, United Kingdom, United States of America, United Rep. of Tanzania, Uruguay.

3. Inter-American Tropical Tuna Commission (IATTC) (1949) (2010)

Objectives

The objective of the Inter-American Tropical Tuna Commission (IATTC) is to ensure the long-term conservation and sustainable use of tuna and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna like species in the Eastern Pacific Ocean, in accordance with the relevant rules of international law.

Area of competence

The IATTC area of application comprises the area of the Pacific Ocean bounded by the coastline of North, Central, and South America and by the following lines: the 50°N parallel from the coast of North America to its intersection with the 150°W meridian; the 150°W meridian to its intersection with the 50°S parallel; and the 50°S parallel to its intersection with the coast of South America.

Species and stocks coverage

Tuna and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna-like species.

Members

Belize, Canada, China, Taiwan Province of China, Colombia, Costa Rica, Ecuador, El Salvador, European Union, France, Guatemala, Kiribati, Japan, Mexico, Nicaragua, Panama, Peru, Republic of Korea, United States of America, Vanuatu, Boliv Rep of Venezuela.

Cooperating Non-Members: Bolivia (Plurinational State), Honduras, Indonesia, Cook Islands.

Maintains an IUU Vessels List since 2005

Maintains a vessel register since 2000

The 1949 Convention for the establishment of an Inter-American Tropical Tuna Commission (USA and Costa Rica)

The Antigua Convention, which was negotiated to strengthen and replace the 1949 Convention establishing the IATTC, entered into force on 27 August 2010.

4. General Fisheries Commission for the Mediterranean (GFCM) (1949)

Objectives:

The purpose of the General Fisheries Commission for the Mediterranean is to promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in its area of competence.

Functions:

The Commission has the following functions and responsibilities:

- to keep under review the state of these resources, including their abundance and the level of their exploitation, as well as the state of the fisheries based thereon;
- to formulate and recommend, in accordance with the provisions of Article V [of the GFCM constitutive agreement], appropriate measures:
 1. for the conservation and rational management of living marine resources, including measures:
 - regulating fishing methods and fishing gear,
 - prescribing the minimum size for individuals of specified species,
 - establishing open and closed fishing seasons and areas,
 - regulating the amount of total catch and fishing effort and their allocation among Members,
 2. for the implementation of these recommendations;
- to keep under review the economic and social aspects of the fishing industry and recommend any measures aimed at its development,
- to encourage, recommend, coordinate and, as appropriate, undertake training and extension activities, as well as research and development activities, including cooperative projects in the areas of fisheries and the protection of living marine resources;
- to assemble, publish or disseminate information regarding exploitable living marine resources and fisheries based on these resources;
- to promote programmes for marine and brackish water aquaculture and coastal fisheries enhancement; to carry out such other activities as may be necessary for the Commission to achieve its purpose as defined above.

Area of competence

The Mediterranean Sea, the Black Sea and connecting waters.

Species and stocks coverage

All living marine resource within the area of competence.

Legal framework

The "Agreement for the Establishment of the General Fisheries Commission for the Mediterranean" was adopted under Article XIV of the FAO Constitution in 1949 and entered

into force on 20 February 1952. It was amended three times (1963, 1972 and 1997) Following a two-year performance review, and according to the decisions taken by the Commission at its 36th and 37th Session, an amendment process of the GFCM legal framework is currently ongoing.

Members

The Members of the Commission shall be such Members and Associate Members of the FAO and such non-member States as are members of the United Nations, any of its Specialized Agencies or the International Atomic Energy Agency, that are:

- (i) coastal States or Associated Members that are situated wholly or partly within the area of competence,
- (ii) States of Associated Members whose vessels engage in fishing within the area of competence or regional economic integration organizations of which any State referred to in (i) or (ii) is a member and to which that State has transferred competence over matters within the purview of the GFCM Agreement.

Member: Albania, Algeria, Bulgaria, Croatia, Cyprus, European Union, Egypt, France, Greece, Israel, Italy, Japan, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Romania, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey.

5. International Commission for the Conservation of Atlantic Tunas (ICCAT) (1966)

Objectives

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas.

Area of competence

All waters of the Atlantic Ocean, including adjacent seas.

Species and stocks coverage

Tuna, tuna-like species and pelagic sharks fished in the ICCAT Convention area.

Currently ICCAT is conducting full assessment of the following stocks:

Yellowfin tuna (*Thunnus albacares*) (Atlantic stock); bigeye tuna (*Thunnus obesus*) (Atlantic stock); skipjack tuna (*Katsuwonus pelamis*) (East and West Atlantic stocks); albacore tuna (*Thunnus alalunga*) (North and South Atlantic and Mediterranean stocks); Atlantic bluefin tuna (*Thunnus thynnus t.*) (West Atlantic stock and East Atlantic and Mediterranean stock); swordfish (*Xiphias gladius*) (North and South Atlantic and Mediterranean stocks); sailfish (*Istiophorus albicans*) (East and West Atlantic stock); blue marlin (*Makaira nigricans*) (Atlantic

stock); white marlin (*Tetrapturus albidus*) (Atlantic stock; blue shark (*Prionace glauca*) (North and South Atlantic stocks); shortfin mako shark (*Isurus oxyrinchus*) (North and South Atlantic stocks); portbeagle (*Lamnansus*) (Northwest, Northeast and Southwest Atlantic stocks).

Other species under study are:

Longbill spearfish (*Tetrapturus pfluegeri*); bullet tuna (*Auxis rochei*); frigate tuna (*Auxis thazard*); Atlantic Spanish mackerel (*Scomberomorus maculatus*); Serra Spanish mackerel (*Scomberomorus brasiliensis*); little tuna (*Euthynnus alletteratus*, *Euthynnus affinis*); Atlantic bonito (*Sardasarda*); Plain bonito (*Orcynopsis unicolor*); Cero (*Scomberomorus regalis*); King mackerel (*Scomberomorus cavalla*); *Scomberomorus* unclassified (*Scomberomorus spp.*); West African Spanish mackerel (*Scomberomorus tritor*); Wahoo (*Acanthocybium solandri*); Dolphinfish (*Coryphaena hippurus*); bigeye thresher (*Alopias superciliosus*); thresher (*Alopias vulpinus*); silky shark (*Carcharhinus falciformis*); oceanic whitetip shark (*Carcharhinus longimanus*); Dusky shark (*Carcharhinus obscurus*); sandbar shark (*Carcharhinus plumbeus*); night shark (*Carcharhinus signatus*); tiger shark (*Galeocerdo cuvier*); longfin mako (*Isurus paucus*); *Pteroplatytrigon violacea* (PST); scalloped hammerhead (*Sphyrna lewini*); great hammerhead (*Sphyrna mokarran*); Smooth hammerhead (*Sphyrna zygaena*).

Members: Member: Albania, Algeria, Angola, Barbados, Belize, Brazil, Canada, Cape Verde, China, Sierra Leone, Côte d'Ivoire, Egypt, Equatorial Guinea, European Union, France, Gabon, Ghana, Guatemala, Guinea, Honduras, Iceland, Japan, Libya, Morocco, Mauritania, Mexico, Namibia, Nicaragua, Nigeria, Norway, Panama, Philippines, Republic of Korea, Russian Federation, Saint Vincent/Grenadines, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Syrian Arab Republic, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States of America, Uruguay, Vanuatu, Boliv Rep of Venezuela.

Cooperating States: Colombia, Curaçao, El Salvador, Suriname, Taiwan Province of China.

Maintains Record of Vessels; IUU vessel list; joint scheme of international inspection

6. Northwest Atlantic Fisheries Organization (NAFO) (1979)

Objectives

The Northwest Atlantic Fisheries Organization's (NAFO) overall objective is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of its area of competence, and to ensure the long term conservation and sustainable use of the fishery resources and, in so doing, to safeguard the marine ecosystems in which these resources are found. Area of competence The waters of the Northwest Atlantic Ocean, north of 35°00' north latitude and west of a line extending due north from 35°00' north latitude and 42°00' west longitude to 59°00' north latitude, thence due west to 44°00' west longitude, and thence due north to the coast of Greenland, and the waters of the Gulf of St. Lawrence, Davis Strait and Baffin Bay south of 78°10' north latitude. Within this area, **NAFO may only regulate fishing activity beyond Coastal States' EEZs.**

NAFO area of competence - High seas, National waters

Species and stocks coverage

All marine fisheries resources, except salmon, tunas, marlins, whales and sedentary species (e.g. shellfish and lobsters).

Members: Canada, Cuba, Denmark, European Union, France, Iceland, Japan, Norway, Republic of Korea, Russian Federation, Ukraine, United States of America. [only four coastal States bordering the Convention area USA, Canada, France (in respect of St. Pierre et Miquelon), and Denmark (in respect of Faroe Islands and Greenland)]

7. North East Atlantic Fisheries Commission (NEAFC) (1982)

Objectives

The objective of North East Atlantic Fisheries Commission (NEAFC) is to ensure the long-term conservation and optimum utilization of the fishery resources within its area of competence, providing sustainable economic, environmental and social benefits.

Area of competence

Those parts of the Atlantic and Arctic Oceans and their dependent seas which lie north of 36° north latitude and between 42° west longitude and 51° east longitude, but excluding:

- (i) the Baltic Sea and the Belts lying to the south and east of lines drawn from Hasenøre Head to Gniben Point, from Korshage to Spodsbjerg and from Gilbjerg Head to the Kullen. and
- (ii) the Mediterranean Sea and its dependent seas as far as the point of intersection of the parallel of 36° latitude and the meridian of 5°36' west longitude.

NEAFC's area of competence also includes the part of the Atlantic Ocean north of 59° north latitude and between 44° west longitude and 42° west longitude.

NEAFC area of competence - High seas, National waters

Species and stocks coverage

All resources of fish, molluscs, crustaceans and including sedentary species, excluding, in so far as they are dealt with by other international agreements, highly migratory species and anadromous stocks. Members

Member: Denmark, European Union, Iceland, Norway, Russian Federation.
* Denmark (in respect of the Faroe Islands and Greenland).

Cooperating Non-Member States: Canada, New Zealand, Saint Kitts and Nevis.

NEAFC maintains NEAFC A list and NEAFC B list to eliminate IUU fishing vessels. It also delists vessels.

8. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (1982)

Objectives

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established in 1982; it responsible for the conservation and management of marine living resources in the Antarctic Ocean.

The Convention's management objectives balance "conservation" and "rational use" of marine living resources to ensure that stocks are harvested sustainably, existing ecological relationships between harvested, dependent and related species are maintained and depleted populations are restored to levels at which their biological productivity is greatest.

Area of competence

All waters bounded by the Antarctic Continent to the south, and to the north by a line starting at 50°S 50°W; thence due east to 30°E longitude; thence due north to 45°S latitude; thence due east to 80°E longitude; thence due south to 55°S latitude; thence due east to 150°E longitude; thence due south to 60°S latitude; thence due east to 50°W longitude; thence due north to the starting point.

Species and stock coverage

All the populations of fin fish, molluscs, crustaceans and all other species of living organisms, including birds, found south of the Antarctic Convergence, but excluding whales and seals, which are the subject of other conventions.

Member: Argentina, Australia, Belgium, Brazil, Chile, China, European Union, France, Germany, India, Italy, Japan, Namibia, New Zealand, Norway, Poland, Republic of Korea, Russian Federation, South Africa, Spain, Sweden, Ukraine, United Kingdom, United States of America, Uruguay.

9. North Atlantic Salmon Conservation Organization (NASCO) (1984)

Objectives

The objective of the North Atlantic Salmon Conservation Organization (NASCO) is to contribute, through consultation and cooperation, to the conservation, restoration, enhancement and rational management of salmon stocks, subject to the Convention, taking into account the best scientific evidence available to it.

Area of competence

Atlantic Ocean north of 36°N, throughout the species' migratory range.

NASCO area of competence - High seas, National waters

Species and stocks coverage

Atlantic salmon (*Salmosalar*) - the Convention applies to salmon stocks which migrate beyond areas of fisheries' jurisdiction of coastal States of the North Atlantic. Members

Member: Canada, Denmark, European Union, Norway, Russian Federation, United States of America.

The establishment of NASCO immediately prohibited fishing for salmon in most parts of the North Atlantic beyond 12 nautical miles from the coast creating a large protected zone or 'sanctuary', free of targeted fisheries. Regulatory measures agreed by NASCO for the distant-water fisheries and measures taken by States of Origin, partly in recognition of their international obligations and partly for domestic management reasons, have resulted in enormous reductions in fishing effort all around the North Atlantic. There are many pressures facing the resource and focusing solely on the fisheries is unlikely to conserve the stocks. NASCO is therefore addressing a wide range of issues.

NASCO and its Parties have adopted and are applying the Precautionary Approach in order to protect the resource and preserve the environments in which it lives. This approach requires that caution be exercised when information is uncertain, unreliable or inadequate. NASCO has developed a range of Precautionary Approach agreements in relation to:

- management of fisheries;
- habitat protection and restoration;
- impacts of aquaculture, introductions and transfers and transgenics;
- stock rebuilding programmes;
- **use of socio-economic factors in management decisions.**

NASCO has also developed a range of guidelines on topics such as **catch and release and establishment of gene banks.**

10. North Pacific Anadromous Fish Commission (NPAFC) (1992)

Objectives

The objective of the North Pacific Anadromous Fish Commission (NPAFC) is to promote the conservation of anadromous stocks in the Convention Area. The Commission, among other measures, has the authority to recommend measures to the States Parties for the conservation of anadromous stocks, coordinate and review enforcement measures, and promote the exchange of information on activities contrary to the provisions of the Convention, catch, effort and stock enhancement information, and scientific research on Pacific salmon and ecologically related species.

Area of competence

The North Pacific Ocean and its adjacent seas, north of 33 degrees North Latitude **beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.**

NPAFC area of competence - **High seas**

Species and stocks coverage

Chum salmon (*Oncorhynchus keta*), Coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), sockeye salmon (*Oncorhynchus nerka*), Chinook salmon (*Oncorhynchus tshawytscha*), cherry salmon (*Oncorhynchus masou*), steelhead trout (*Oncorhynchus mykiss*).

Members

Canada, Japan, Republic of Korea, Russian Federation, United States of America.

11. Commission for the Conservation of Southern Bluefin Tuna (CCSBT) (1993)

Objectives

The objective of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is to ensure, through appropriate management, the conservation and optimum utilization of the global Southern Bluefin Tuna (SBT) fishery.

The Commission is responsible for setting a total allowable catch (TAC) and its allocation among the members; takes decisions to support and implement fishery management; and acts as a coordination mechanism for member's activities in relation to the SBT fishery.

Area of competence:

The Convention for the Conservation of Southern Bluefin Tuna sets no geographic limits of competence; it extends over all national waters and the high seas, where southern bluefin tuna are found.

Species and stock coverage:

Southern bluefin tuna (*Thunnus maccoyii*).

Members of the Commission

Australia, Indonesia, Japan, Republic of Korea, New Zealand.

Members of the Extended Commission: Australia, Indonesia, Japan, Republic of Korea, New Zealand. Fishing Entity of Taiwan.

Co-operating Non-Members: European Union, South Africa, Philippines.

On 20 May 1994 the then existing voluntary management arrangement between Australia, Japan and New Zealand was formalised when the Convention for the Conservation of

Southern Bluefin Tuna, which had been signed by the three countries in May 1993, came into force. The Convention created the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). The CCSBT is headquartered in Canberra, Australia.

Other fishing nations were active in the SBT fishery, which reduced the effectiveness of the member's conservation and management measures. The principal non member nations were Korea, Taiwan and Indonesia. There were also a number of other fishing vessels flying flags of convenience, which operated in the fishery. As a matter of policy, the CCSBT has encouraged the membership of these countries.

The Republic of Korea and Indonesia joined the Commission on 17 October 2001 and 8 April 2008 respectively.

The Fishing Entity of Taiwan's membership of the Extended Commission became effective on 30 August 2002.

At its meeting in October 2003, the CCSBT agreed to invite countries with an interest in the fishery to participate in its activities as formal Cooperating Non-Members. Cooperating Non-Members participate fully in the business of the CCSBT but cannot vote. Acceptance as a Cooperating Non-Member requires adherence to the management and conservation objectives of the CCSBT and agreed catch limits. Cooperating Non-Member status is regarded as a transitional measure to full membership and accession to the Convention.

The Philippines, South Africa and the European Community were formally accepted as Cooperating Non-Members on 2 August 2004, 24 August 2006 and 13 October 2006 respectively.

12. Indian Ocean Tuna Commission (IOTC) (1993)

Objective

The Indian Ocean Tuna Commission (IOTC) is an intergovernmental organization mandated to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. The objective of the Commission is to promote the conservation and optimal utilization of tuna and tuna-like stocks covered by the IOTC Agreement, and to encourage sustainable development of fisheries.

Functions

In accordance with Article V of the IOTC Agreement, the main functions of the IOTC are:

- to keep under review the conditions and trends of the stocks and to gather, analyse and disseminate scientific information, catch and effort statistics and other relevant data;
- to encourage, recommend and coordinate research and development activities in respect of the stocks and fisheries covered by the Agreement;
- to adopt conservation and management measures on the basis of scientific evidence;

- to keep under review the economic and social aspects of the fisheries, bearing in mind, in particular, the interests of developing coastal states.

Area of competence The Indian Ocean (defined for the purpose of the Agreement as being FAO Statistical Areas 51 and 57), and adjacent seas, north of the Antarctic Convergence, insofar as it is necessary to cover such seas for the purpose of conserving and managing stocks that migrate into or out of the Indian Ocean. In 1999, the Commission extended the western boundary of the IOTC statistical area from 30°E to 20°E, thus eliminating the gap in between the areas covered by the IOTC and ICCAT.

IOTC area of competence - High seas, National waters

Species and stocks coverage

Tuna and tuna-like species in the Indian Ocean and adjacent seas – the exact list of species is available at <http://www.iotc.org/English/info/mission.php>. In addition, the Commission has instructed the Secretariat to collate data on non-target, associated and dependent species affected by tuna fishing operations, e.g. sharks and sea-birds. Legal framework

The Agreement for the Establishment of the Indian Ocean Tuna Commission was concluded under Article XIV of the FAO Constitution. It was approved by the FAO Council in November 1993 and came into force upon accession of the tenth member in March 1996.

Members

Current membership:

Membership in the Commission is open to Members and Associate Members of FAO that are: (i) coastal States or Associate Members situated wholly or partly within the Area; (ii) States or Associate Members whose vessels engage in fishing in the Area for stocks covered by the Agreement; or (iii) regional economic integration organizations of which any State referred to in subparagraphs (i) or (ii) above is a member and to which that State has transferred competence over matters within the purview of the Agreement. Parties qualified to accede to the Commission may do so by depositing with the Director-General of FAO an instrument formally accepting to be bound by the conditions of the IOTC Agreement.

Member: Australia, Belize, China, Comoros, Eritrea, European Union, France, Guinea, India, Indonesia, Iran (Islamic Rep. of), Japan, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Republic of Korea, Seychelles, Sierra Leone, Sri Lanka, Sudan, Thailand, United Kingdom, United Rep. of Tanzania, Vanuatu, Yemen.

Cooperating Non-Contracting Party: Senegal, South Africa.

The IOTC is an autonomous organization that is fully funded by its member states.

Structure

The governing body of the IOTC is the Commission. It is composed of all members and is empowered to adopt conservation and management measures. Conservation and

management measures binding on members of the Commission must be adopted by a two-thirds majority of members present and voting. Each member of the Commission has one vote. Individual members objecting to a decision are not bound by it. Non-binding recommendations concerning conservation and management of the stocks for furthering the objectives of the Agreement need only be adopted by a simple majority of its members present and voting. Sessions of the Commission are normally held annually.

The work of the Commission is assisted by a Scientific Committee, a Compliance Committee, and a Standing Committee on Administration and Finance, as well as numerous working parties.

13. Lake Victoria Fisheries Organization (LVFO) (1994)

Objectives

Lake Victoria Fisheries Organization (LVFO) is a specialized Institution of EAC with the mandate to coordinate the management of the fisheries resources of Lake Victoria for sustainable development and utilization, and to spearhead aquaculture development in the Basin. The Organization was established by a [Convention](#) signed on 30 June 1994 by the Republic of Kenya, the United Republic of Tanzania and the Republic of Uganda sharing Lake Victoria. LVFO is registered under Article 102 of the United Nations Charter and recognized as a Regional Fisheries Management Organization (RFMO).

The objectives of the Lake Victoria Fishing Organization (LVFO) are to foster cooperation among the Contracting Parties, harmonize national measures for the sustainable utilization of the living resources of the Lake and to develop and adopt conservation and management measures.

Area of competence

Lake Victoria.

LVFO area of competence - Inland waters

Species and stocks coverage

All aquatic species in Lake Victoria. Members

Member: [Kenya](#), [Uganda](#), [United Rep. of Tanzania](#).

14. Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (CCBSP) (1995)

Objectives The Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (CCBSP) has four main objectives:

- to establish an international regime for conservation, management, and optimum utilization of pollock resources in the Convention Area;
- to restore and maintain the pollock resources in the Bering Sea at levels which will permit their maximum sustainable yield;
- to cooperate in the gathering and examining of factual information concerning pollock and other living marine resources in the Bering Sea;

- and to provide, if the Parties agree, a forum in which to consider the establishment of necessary conservation and management measures for living marine resources other than pollock in the Convention Area as may be required in the future.

Area of competenceThe area of competence of the CCBSP is the **high seas area of the Bering Sea beyond 200 nautical miles from the baselines from which the breadth of the territorial sea of the coastal States of the Bering Sea is measured.**

Species and stocks coverage;Alaskapollock (*Theragrachalcogramma*). Members

Member: China, Japan, Republic of Korea, Poland, Russian Federation, United States of America.

15.Regional Commission for Fisheries (RECOFI) (2001)

Objective

The purpose of the Regional Commission for Fisheries (RECOFI) is to promote the development, conservation, rational management and best utilization of living **marine resources**, as well as **the sustainable development of aquaculture** within its area of Agreement.

Functions

The Commission has the following functions and responsibilities:

- to keep under review the state of the resources, including their abundance and the level of their exploitation, as well as the state of the fisheries based thereon;
- to formulate and recommend appropriate measures for the conservation and rational management of living marine, applying the precautionary approach and based on the best scientific evidence available, including measures:
 - regulating fishing methods and fishing gear,
 - prescribing the minimum size for individuals of specified species,
 - establishing open and closed fishing seasons and areas,
 - **regulating the amount of total catch and of fishing effort and their allocation among Members.**
- **to keep under review the economic and social aspects of the fishing industry and recommend any measures aimed at its development;**
- to encourage, recommend, coordinate and, as appropriate, undertake training and extension activities in all aspects of fisheries;

- to encourage, recommend, coordinate and, as appropriate, undertake research and development activities, **including cooperative projects in the areas of fisheries and the protection of living marine resources**;
- to assemble, publish or disseminate information regarding exploitable living marine resources and fisheries based on these resources;
- to promote programmes for aquaculture and fisheries enhancement;
- to carry out such other activities as may be necessary for RECOFI to achieve its purposes as defined above.

Area of competence The Commission carries out its functions and responsibilities in the region, bounded in the south by the following rhomb lines: from RasDhabat Ali in (16° 39'N, 53° 3'30"E) then to a position in (16° 00'N, 53° 25'E) then to a position in (17° 00'N, 56° 30'E) then to a position in (20° 30'N, 60° 00'E) then to Ras Al-Fasteh in (25° 04'N, 61° 25'E).

RECOFI area of competence

National waters

Current membership: Bahrain, Iraq, Iran (Islamic Rep. of), Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates.

Species and stocks coverage

The Commission covers all living marine resources in its area of competence.

Legal framework

The Agreement for the Establishment of the Commission was concluded under Article XIV of the FAO Constitution. It was approved by the FAO Council in November 1999 and came into force on 26 February 2001. The Rules of procedure were adopted at the Commission's First Session, October 2001.

Structure

Commission

The Commission is the governing body of RECOFI. It is composed of one delegate from all Members. The Commission has established two subsidiary bodies, the Working Group on Fisheries Management and the Working Group on Aquaculture. The Commission is empowered to adopt conservation and management measures. Conservation and management measures binding on Members of the Commission must be adopted by a two-thirds majority of Members present and voting. Each Member has one vote. Any Member of the Commission may object to a decision: Members objecting to a decision are not bound by it. The Commission normally meets every two years at the time and date the Commission determines.

16.South East Atlantic Fishery Organization (SEAFO) (2001)

Objectives

The objective of South East Atlantic Fishery Organization (SEAFO) is to ensure the long-term conservation and sustainable use of the fishery resources in SEAFO's area of competence.

Area of competence

All waters beyond areas of national jurisdiction in the area bounded by a line joining the following points along parallels of latitude and meridians of longitude:

Beginning at the outer limit of waters under national jurisdiction at a point 6° South, thence due west along the 6° South parallel to the meridian 10° West, thence due north along the 10° West meridian to the equator, thence due west along the equator to the meridian 20° West, thence due south along the 20° West meridian to a parallel 50° South, thence due east along the 50° South parallel to the meridian 30° East, thence due north along the 30° East meridian to the coast of the African continent.

SEAFO area of competence - High seas

Species and stocks coverage

All living marine resources of fish, molluscs, crustaceans and other sedentary species within the SEAFO Convention Area, but excluding:

1. sedentary species subject to the fishery jurisdiction of coastal States pursuant to article 77 paragraph 4 of the 1982 United Nations Convention on the Law of the Sea; and
2. highly migratory species listed in Annex I of the 1982 United Nations Convention on the Law of the Sea.

Members

Angola, European Union, Japan, Namibia, Norway, Republic of Korea, South Africa.

The Convention is the first to create a regional management organization after the adoption of the UNFSA. It is established in line with the provisions of UNCLOS Article 118 and UNFSA. The Convention Area excludes EEZs of the coastal States in the region. SEAFO maintains an IUU vessels list like NAFO, NEAFC and CCAMLR

17. Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC) (2004)

Objectives

The objective of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC) is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the western and central Pacific Ocean in accordance with the 1982 United Nations Convention on the Law of the Sea and the 1995 UN Fish Stocks Agreement.

Area of competence

All waters of the Pacific Ocean bounded to the south and to the east by a line drawn from the south coast of Australia due south along the 141° meridian of east longitude to its intersection with the 55° parallel of south latitude; thence due east along the 55° parallel of south latitude to its intersection with the 150° meridian of east longitude; thence due south along the 150° meridian of east longitude to its intersection with the 60° parallel of south latitude; thence due east along the 60° parallel of south latitude to its intersection with the 130° meridian of west longitude; thence due north along the 130° meridian of west longitude to its intersection with the 4° parallel of south latitude; thence due west along the 4° parallel of south latitude to its intersection with the 150° meridian of west longitude; thence due north along the 150° meridian of west longitude.

WCPFC area of competence

High seas, National waters

Species and stocks coverage

Highly migratory fish stocks, defined as all stocks of the species listed in Annex I of the 1982 United Nations Convention on the Law of the Sea:

Yellowfin tuna (*Thunnus albacores*); blackfin tuna (*Thunnus atlanticus*); little tuna (*Euthynnus alletteratus*, *Euthynnus affinis*); southern bluefin tuna (*Thunnus maccoyii*); frigate mackerel (*Auxis thazard*; *Auxis rochei*); pomfrets (family *Bramidae*); marlins (*Tetrapturus angustirostris*, *Tetrapturus belone*, *Tetrapturus pfluegeri*, *Tetrapturus albidus*, *Tetrapturus audax*, *Tetrapturus georgei*, *Makaira mazara*, *Makaira indica*, *Makaira nigricans*); sail-fish (*Istiophorus platypterus*; *Istiophorus albidus*); swordfish (*Xiphias gladius*); Sauries (*Scomberesox saurus*, *Cololabis saira*, *Cololabis adocetus*, *Scomberesox saurus scombroides*); oceanic sharks (*Hexanchus griseus*, *Cetorhinus maximus*, Family *Alopiidae*, *Rhincodontypus*, Family *Carcharhinidae*, Family *Sphyrnidae*, Family *Isurida*).

Note that not all of these species are indigenous to the Pacific Ocean, and that Annex I of the 1982 United Nations Convention on the Law of the Sea also contains marine mammals (dolphins and cetaceans).

Members

Australia, Canada, China, Cook Islands, European Union, Republic of Fiji, France, Japan, Kiribati, Marshall Islands, Fed.States of Micronesia, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Taiwan Province of China, Tuvalu, United States of America, Vanuatu.

Participating Non-Independent Territories: American Samoa, Commonwealth of the Northern Mariana Islands, French Polynesia, Guam, New Caledonia, Tokelau, Wallis and Futuna.

Participating Non-Member States: Belize, Democratic People's Republic of Korea, Ecuador, El Salvador, Indonesia, Mexico, Senegal, St Kitts and Nevis, Panama, Thailand, Vietnam.

18.South Indian Ocean Fisheries Agreement (SIOFA) (2006)

Objectives

The objectives of the South Indian Ocean Fisheries Agreement (SIOFA) are to ensure the long-term conservation and sustainable use of the fishery resources in its area of competence through cooperation among the Contracting Parties, and to promote the sustainable development of fisheries, taking into account the needs of developing States that are Contracting Parties to the Agreement, and in particular the least-developed among them and small island developing States. SIOFA is not a regional fishery "body" (RFB); it is a regional fishery "arrangement" (RFA), as referred to in several provisions of the 1995 United Nations Fish Stocks Agreement. It has neither a seat nor a permanent secretariat.

Area of competence

SIOFA's area of competence is bounded by a line joining the following points along parallels of latitude and meridians of longitude, excluding waters under national jurisdiction:

Commencing at the landfall on the continent of Africa of the parallel of 10° North; from there east along that parallel to its intersection with the meridian of 65° East; from there south along that meridian to its intersection with the equator; from there east along the equator to its intersection with the meridian of 80° East; from there south along that meridian to its intersection with the parallel of 20° South; from there east along that parallel to its landfall on the continent of Australia; from there south and then east along the coast of Australia to its intersection with the meridian of 120° East; from there south along that meridian to its intersection with the parallel of 55° South; from there west along that parallel to its intersection with the meridian of 80° East; from there north along that meridian to its intersection with the parallel of 45° South; from there west along that parallel to its intersection with the meridian of 30° East; from there north along that meridian to its landfall on the continent of Africa.

SIOFA area of competence - High seas

Species and stocks coverage

All marine fish stocks.

Members

Australia, Cook Islands, European Union, Mauritius, Seychelles.

19. Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish) (2010)

Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish), came into being in 2010 under Article XIV of the FAO Constitution)

Mission and Objectives

The objectives of CACFish are to promote the development, conservation, rational management and best utilization of living aquatic resources, as well as the sustainable development of aquaculture in Central Asia and the Caucasus.

To achieve its objectives, CACFish has the following functions and responsibilities:

- keep under review the state of living aquatic resources, including their abundance and the level of their exploitation, as well as the state of the fisheries and aquaculture;
- formulate and recommend appropriate measures for the conservation and rational management of living aquatic resources, and the implementation of these recommendations;
- keep under review the **economic and social aspects** of the fishing and aquaculture industry and recommend any measures aimed at its development;
- encourage, recommend, coordinate and, as appropriate, undertake activities relating to training and extension, research and development, including **cooperative projects** in the areas of fisheries and aquaculture;
- assemble, publish or disseminate information regarding exploitable living aquatic resources and fisheries and aquaculture based on these resources;
- promote programmes for aquaculture and fisheries enhancement;
- **promote women's participation in aquaculture and capture fisheries development;**
- **transfer appropriate technologies and techniques for development of small-scale fisheries and aquaculture;**
- contribute to knowledge generation and raising the awareness about fisheries and aquaculture in the Central Asian and Caucasus region;
- promote liaison and cooperation among and within governmental organizations and with nongovernmental organizations as appropriate;
- carry out such other activities as may be necessary for the Commission to achieve its purpose as defined above.

20. South Pacific Regional Fisheries Management Organization (SPRFMO) (2012)

Objectives

The South Pacific Regional Fisheries Management Organization (SPRFMO) is an inter-governmental organization that aims, through the application of the precautionary approach and an ecosystem approach to fisheries management, to ensure the long-term conservation and sustainable use of fishery resources within the Convention area and, in so doing, to safeguard the marine ecosystems in which these resources occur.

Area of competence

The waters of the Pacific Ocean beyond areas of national jurisdiction, defined as follows:

- (a) *East of* a line extending south along the 120° meridian of east longitude from the outer limit of the national jurisdiction of Australia off the south coast of Western Australia to the intersection with the 55° parallel of south latitude; then due east along the 55° parallel of south latitude to the intersection with the 150° meridian of east longitude; then due south along the 150° meridian of east longitude to the intersection with the 60° parallel of south latitude;
- (b) *North of* a line extending east along the 60° parallel of south latitude from the 150° meridian of east longitude to the intersection with the 67° 16' meridian of west longitude;
- (c) *West of* a line extending north along the 67° 16' meridian of west longitude from the 60° parallel of south latitude to its intersection with the outer limit of the national jurisdiction of Chile then along the outer limits of the national jurisdictions of Chile, Peru, Ecuador and Colombia to the intersection with the 2° parallel of north latitude; and
- (d) *South of* a line extending west along the 2° parallel of north latitude (but not including the national jurisdiction of Ecuador (Galapagos Islands) to the intersection with the 150° meridian of west longitude; then due north along the 150° meridian of west longitude to its intersection with 10° parallel of north latitude, then west along the 10° parallel of north latitude to its intersection with the outer limits of the national jurisdiction of the Marshall Islands, and then generally south and around the outer limits of the national jurisdictions of Pacific States and territories, New Zealand and Australia until it connects to the commencement of the line described in paragraph (a) above.

SPRFMO also has competence in the waters of the Pacific Ocean beyond areas of national jurisdiction bounded by the 10° parallel of north latitude and the 20° parallel of south latitude and by the 135° meridian of east longitude and the 150° meridian of west longitude.

SPRFMO area of competence - High seas

Species and stocks coverage

All species except highly migratory species.

Members

Australia, Belize, Chile, China, Cook Islands, Cuba, European Union, Denmark, Republic of Korea, New Zealand, Russian Federation, Taiwan Province of China.

NOTE: *Denmark in respect of the Faroe Islands.*

Challenges ahead for RFMOs

Though **RFBs are composed of independent States, they are not supranational organizations.** States come together under the aegis of a RFB because of their common interest and concern for conserving and managing their mandated fish stocks. Therefore, RFBs can only be as effective as their members permit.

The **perceived lack of action by RFMOs** and their inability in some cases to stem stock declines should be viewed in the context of the obstacles that many are facing. A lack of political commitment by the members of some RFMOs and unyielding positions incompatible with sound regional fisheries management have thwarted, if not stalled, efforts undertaken within some RFMOs to meet and address conservation and management challenges. This situation hinders RFMO performance, while criticism is directed at the organizations rather than at their members.

Members must collaborate effectively and take difficult decisions if they are to be successful – even though not all members have congruent interests. The strong political will of member States of each RFB must be the primary prerequisite for the effective role of RFBs.

(Source: <http://www.fao.org/fishery/rfb/search/en>)

Ecolabel – A Market Driven Tool for Responsible Fisheries Management

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What is ecolabelling / fishery certification?

Ecolabelling is a voluntary product labeling conveying environmental information to consumers that seeks to create a market-based incentive for better management of fisheries. Fishery certification is a voluntary process that involves the procedure by which a third party gives assurance that a product, process or service conforms to specified requirements and whether it meets or passes a given standard. If successful, products from the fishery are usually entitled to use an eco-label in the marketplace after a traceability audit (chain of custody certification) has been completed.

Responsible Fisheries Management



Responsible Fisheries management is the management of the fishery through an appropriate policy, legal and institutional framework adopts long term measures for conservation and sustainable use of the resource.




The FAO-Based Responsible Fisheries Management Certification Program is a voluntary, third party independent verification that, fisheries are operating according to the criteria specified by the FAO Code of Conduct for Responsible Fisheries (FAO Code). The FAO Guidelines for the Eco-labeling of Products from Marine Capture Fisheries hence Eco labeling / Certification can be used as a tool for responsible fisheries management as it encompasses the principles of fisheries management by maintaining the sustainability of the fish stocks, environmental interactions and compliance with the rules and regulations of a region. It also provides a market incentive in terms of better pricing for eco labelled/

certified products but at the same time maintaining the sustainability of the fishery resources.

Types of ecolabelling schemes

Few inventories of wild capture seafood certification programmes with varying sustainability claims identified by the WWF is as follows:

Name & logo	Details
	<p>The countries and regional economic integration organisations participating in the Agreement on the International Dolphin Conservation Program (AIDCP) announced a program to certify and label tuna caught in the eastern Pacific Ocean consistent with the AIDCP and without mortality or serious injury to dolphins. The AIDCP Dolphin Safe Tuna Certification is supported by a comprehensive and transparent multilateral tracking and verification system administered by member governments and the treaty organisation that ensures full consumer confidence in the AIDCP Dolphin Safe label and the certification behind it. The Agreement on the International Dolphin Conservation Program, a legally-binding multilateral agreement which entered into force in February 1999, established this program. The Inter-American Tropical Tuna Commission (IATTC) provides the Secretariat for the program. All participating states have the duty to take, or to cooperate with other States in taking, such measures as may be necessary for the conservation and management of living marine resources</p> <p style="text-align: center;">References http://www.iattc.org/</p>
<p>Clean Green of the Southern Rock lobster Fishery</p>	
	<p>The Clear Green programme is a product certification scheme on "pot to plate" environmental, work place and food safety, quality and animal welfare standards for Southern Rocklobster. The elements of the program were trialed in 2004 with just three fishers and three processors. Following an audit by an independent body these standards were then finalised and approved. The Australian Southern Rocklobster industry is committed to ecological sustainable development (ESD). It recognises the imperatives of delivering an exclusive and safe ('clean') food product of the highest quality to our customers through to best practice ('green') in dealing with sustainability of the marine environment in its broadest context. It also values the delivery of a safe working environment for industry participants measurable in improved safety standards aboard its vessels and in its processing facilities.</p> <p style="text-align: center;">References http://www.southernrocklobster.com/cleangreen/default.aspx http://www.jas-anz.com.au/ www.sai-global.com</p>

<p>Friend of the Sea</p> 	<p>Friend of the Sea is a non-profit non- governmental organisation (NGO) for the conservation of marine habitat by means of market incentives, in particular the certification and promotion of sustainable seafood and products from sustainable fisheries and aquaculture. Friend of the Sea is currently a significant sustainable seafood certification scheme in the world, having assessed more than 10 million MT of wild-catch and 500 thousand MT of farmed products.</p> <p>References http://www.friendofthesea.org</p>
<p>KRAV</p> 	<p>Sustainable fishing standards are created to drive development in the fishing industry towards a sustainable fishing and processing. They have been developed during a long process involving experts in many areas. In 2004, KRAV issued standards for sustainable fishing in the Scandinavian jurisdiction. The standards consist of five (5) sets of rules that cover all aspects of fishing, processing, and sales. The standards include all parts of the chain of custody from the fishery to the retailers:</p> <ol style="list-style-type: none"> 1. Quality assurance 2. Stock assessment 3. Fishing vessels 4. Fishing methods 5. Landing and processing <p>These standards were developed for conditions in Scandinavia and are neither tested nor intended for other areas. The KRAV standards include also include: requirements concerning fuel used by fishing vessels, the type of motor, the paint used on ships, etc. The environmental and fisheries management dimension focuses more on the equipment and operational impacts (fuel pollution, etc) than on the actual habitat and marine stock environment. From 2010 KRAV will also accept applications for fish stocks outside Scandinavia.</p>
<p>Dolphin Safe of Earth Inland Institute</p> 	<p>Earth Island Institute (EII) monitors tuna companies around the world to ensure the tuna is caught by methods that do not harm dolphins and protect the marine ecosystem. EII standards prevent harm to dolphins and are adhered to by more than 90% of the world's tuna companies. EII has established a tuna monitoring program with staff monitors around the world who observe operations at tuna canneries, offloading ports, and cold storage facilities, as well as on board fishing vessels and transshipment sites, to ensure that tuna supplies are indeed "Dolphin Safe." It is one of the largest private food monitoring systems in the world. It works with tuna companies - import associations, fishing fleets, canners, and brokers - to establish Dolphin Safe policies for each company</p> <p>References http://www.earthisland.org/dolphinSafeTuna/</p>

Marine Stewardship Council



The Marine Stewardship Council (MSC) is an independent non-profit organisation that was set up in 1997 to offer a solution to the global problem of overfishing. The MSC's fishery certification program and seafood ecolabel recognise and reward sustainable fishing. MSC is a global organisation working with fisheries, seafood companies scientists, conservation groups and the public to promote the best environmental choice in seafood. The MSC runs a sustainability program, working with partners to transform the world's seafood markets and promote sustainable fishing practices. With experts MSC developed standards for sustainable fishing and seafood traceability. They ensure that MSC-labelled seafood comes from, and can be traced back to, a sustainable fishery. The MSC environmental standard for sustainable fishing is the standard that a fishery must meet to become certified, and is based on 3 principles and 31 performance indicators. Only seafood from an MSC certified fishery can carry the blue MSC ecolabel. The standard is science-based and applies to wild-capture fisheries only – whatever their size, type or location but does not apply to farmed fish. Under the MSC program every fishery is measured against these principles, but the unique circumstances of the fishery are taken into account. The actions that different fisheries take to show they meet the 3 principles vary in every case

Comparison of ecolabels

Accenture study on the comparison of the ecolabelling schemes revealed there are many good practices used to foster ecologically sustainable fishing and management practices. However, most of identified ecolabels are neither consistent nor coherent across all assessed performance areas, preventing them from being fully effective and credible. This also shows there is much room to improve and further develop this field. None of the standards analysed are in complete compliance with the criteria identified and defined by WWF as necessary for credible ecolabels or certification programs. The Marine Stewardship Council (MSC) is the only ecolabel that is close enough to be considered compliant with the criteria.

What is Marine Stewardship Council (MSC)

Marine Stewardship Council (MSC) is a non-profit organization established to promote sustainable fisheries and responsible fishing practices worldwide. The MSC has developed a logo that informs consumers that when they buy seafood products with a MSC logo, they are supporting healthier oceans and a healthier environment. Only fisheries certified to be sustainable would be using the MSC logo. The purpose of the MSC certification is to inform the consumers that this product was caught from a well-managed and sustainable fishery. At the centre of the MSC is a set of *Principles and Criteria for Sustainable Fishing* which is used as a standard in a third party, independent and voluntary

certification programme. These were developed by means of an extensive, international consultative process through which the views of stakeholders in fisheries were gathered.

These Principles reflect a recognition that a sustainable fishery should be based upon:

- The maintenance and re-establishment of healthy populations of targeted species;
- The maintenance of the integrity of ecosystems;
- The development and maintenance of effective fisheries management systems, taking into account all relevant biological, technological, economic, social, environmental and commercial aspects; and
- Compliance with relevant local and national local laws and standards and international understandings and agreements

The Principles and Criteria are further designed to recognise and emphasise that management efforts are most likely to be successful in accomplishing the goals of conservation and sustainable use of marine resources when there is full co-operation among the full range of fisheries stakeholders, including those who are dependent on fishing for their food and livelihood.

On a voluntary basis, fisheries which conform to these Principles and Criteria will be eligible for certification by independent MSC-accredited certifiers. Fish processors, traders and retailers will be encouraged to make public commitments to purchase fish products only from certified sources. This will allow consumers to select fish products with the confidence that they come from sustainable, well managed sources. It will also benefit the fishers and the fishing industry who depend on the abundance of fish stocks, by providing market incentives to work towards sustainable practices. Fish processors, traders and retailers who buy from certified sustainable sources will in turn benefit from the assurance of continuity of future supply and hence sustainability of their own businesses.

The MSC promotes equal access to its certification programme irrespective of the scale of the fishing operation. The implications of the size, scale, type, location and intensity of the fishery, the uniqueness of the resources and the effects on other ecosystems will be considered in every certification.

The MSC further recognises the need to observe and respect the long-term interests of people dependent on fishing for food and livelihood to the extent that it is consistent with ecological sustainability, and also the importance of fisheries management and operations being conducted in a manner consistent with established local, national, and international rules and standards as well as in compliance with the MSC Principles and Criteria.

Preamble

The following Principles & Criteria are intended to guide the efforts of the Marine Stewardship Council towards the development of sustainable fisheries on a global basis. They were developed assuming that a sustainable fishery is defined, for the purposes of MSC certification, as one that is conducted in such a way that:

- it can be continued indefinitely at a reasonable level;
- it maintains and seeks to maximise, ecological health and abundance,

- it maintains the diversity, structure and function of the ecosystem on which it depends as well as the quality of its habitat, minimising the adverse effects that it causes;
- it is managed and operated in a responsible manner, in conformity with local, national and international laws and regulations;
- it maintains present and future economic and social options and benefits;
- it is conducted in a socially and economically fair and responsible manner.

The Principles represent the overarching philosophical basis for this initiative in stewardship of marine resources: the use of market forces to promote behaviour which helps achieve the goal of sustainable fisheries. They form the basis for detailed Criteria which will be used to evaluate each fishery seeking certification under the MSC programme. Although the primary focus is the ecological integrity of world fisheries, the principles also embrace the human and social elements of fisheries. Their successful implementation depends upon a system which is open, fair, based upon the best information available and which incorporates all relevant legal obligations. The certification programme in which these principles will be applied is intended to give any fishery the opportunity to demonstrate its commitment to sustainable fishing and ultimately benefit from this commitment in the market place.

Scope

The scope of the MSC Principles and Criteria relates to marine fisheries activities up to but not beyond the point at which the fish are landed. However, MSC-accredited certifiers may be informed of serious concerns associated with post-landing practices.

The MSC Principles and Criteria apply at this stage only to wild capture fisheries (including, but not limited to shellfish, crustaceans and cephalopods). Aquaculture and the harvest of other species are not currently included.

Issues involving allocation of quotas and access to marine resources are considered to be beyond the scope of these Principles and Criteria.

PRINCIPLE 1

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery

Intent:

The intent of this principle is to ensure that the productive capacities of resources are maintained at high levels and are not sacrificed in favour of short term interests. Thus, exploited populations would be maintained at high levels of abundance designed to retain

their productivity, provide margins of safety for error and uncertainty, and restore and retain their capacities for yields over the long term.

Criteria:

1. The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity.
2. Where the exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level consistent with the precautionary approach and the ability of the populations to produce long-term potential yields within a specified time frame.
3. Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

PRINCIPLE 2:

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

Intent:

The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

Criteria:

1. The fishery is conducted in a way that maintains natural functional relationships among species and should not lead to trophic cascades or ecosystem state changes.
2. The fishery is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels and avoids or minimises mortality of, or injuries to endangered, threatened or protected species.
3. Where exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

PRINCIPLE 3:

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

Intent:

The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

A. Management System Criteria:

1. The fishery shall not be conducted under a controversial unilateral exemption to an international agreement.

The management system shall:

2. Demonstrate clear long-term objectives consistent with MSC Principles and Criteria and contain a consultative process that is transparent and involves all interested and affected parties so as to consider all relevant information, including local knowledge. The impact of fishery management decisions on all those who depend on the fishery for their livelihoods, including, but not confined to subsistence, artisanal, and fishing-dependent communities shall be addressed as part of this process;
3. Be appropriate to the cultural context, scale and intensity of the fishery – reflecting specific objectives, incorporating operational criteria, containing procedures for implementation and a process for monitoring and evaluating performance and acting on findings;
4. Observe the legal and customary rights and long term interests of people dependent on fishing for food and livelihood, in a manner consistent with ecological sustainability;
5. Incorporates an appropriate mechanism for the resolution of disputes arising within the system;
6. Provide economic and social incentives that contribute to sustainable fishing and shall not operate with subsidies that contribute to unsustainable fishing;
7. Act in a timely and adaptive fashion on the basis of the best available information using a precautionary approach particularly when dealing with scientific uncertainty;

8. Incorporate a research plan – appropriate to the scale and intensity of the fishery – that addresses the information needs of management and provides for the dissemination of research results to all interested parties in a timely fashion;
9. Require that assessments of the biological status of the resource and impacts of the fishery have been and are periodically conducted;
10. Specify measures and strategies that demonstrably control the degree of exploitation of the resource, including, but not limited to:
 - a) Setting catch levels that will maintain the target population and ecological community's high productivity relative to its potential productivity, and account for the non-target species (or size, age, sex) captured and landed in association with, or as a consequence of, fishing for target species;
 - b) Identifying appropriate fishing methods that minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
 - c) Providing for the recovery and rebuilding of depleted fish populations to specified levels within specified time frames;
 - d) Mechanisms in place to limit or close fisheries when designated catch limits are reached;
 - e) Establishing no-take zones where appropriate;
11. Contains appropriate procedures for effective compliance, monitoring, control, surveillance and enforcement which ensure that established limits to exploitation are not exceeded and specifies corrective actions to be taken in the event that they are.

B. Operational Criteria

Fishing operation shall:

12. Make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimise mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive;
13. Implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
14. Not use destructive fishing practices such as fishing with poisons or explosives;
15. Minimize operational waste such as lost fishing gear, oil spills, on-board spoilage of catch, etc.;

16. Be conducted in compliance with the fishery management system and all legal and administrative requirements; and
17. Assist and co-operate with management authorities in the collection of catch, discard, and other information of importance to effective management of the resources and the fishery.

The following is a flow chart of MSC certification principles:

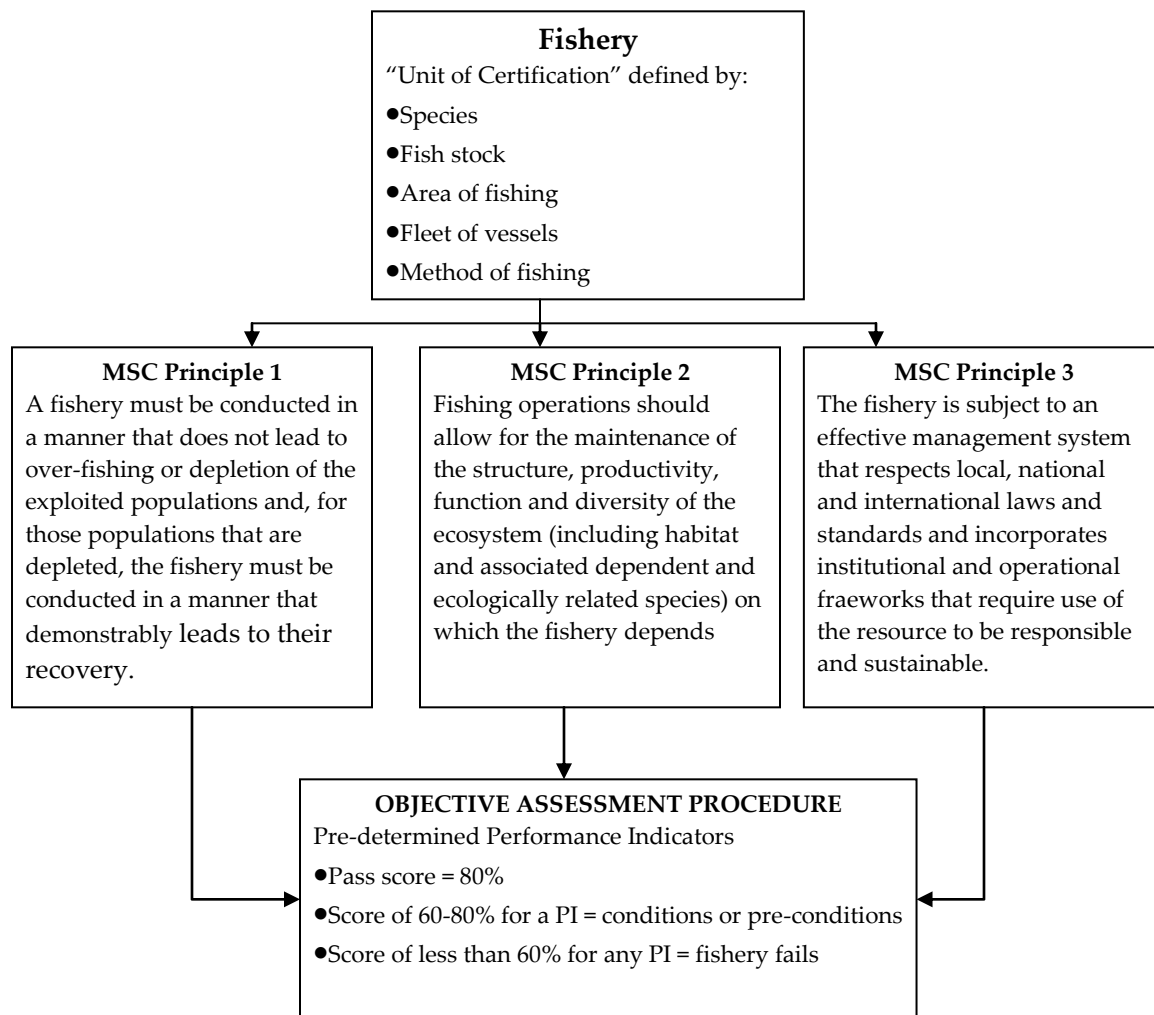


Figure 1. Flow chart showing the MSC certification principles

Guidance for the Assessment of Small-Scale and Data-Deficient Fisheries

The Marine Stewardship Council promotes equal access to its certification programme regardless of the scale of fishery operation. All types of fisheries are eligible to participate and be assessed against the MSC Standard - the Principles and Criteria for Sustainable Fishing.

There are situations in which a fishery may have insufficient data to show that it meets the MSC Standard. To ensure that these fisheries can participate in the MSC programme, the MSC has been developing methodological guidance to assist certifiers involved in assessing such fisheries.

The new guidelines introduce a risk assessment that can be initiated if fisheries lack full and complete scientific data for key environmental indicators needed to assess performance. The MSC's conventional methodology draws on scientific data to produce sound and objective fishery assessments against the MSC standard. Many small fisheries, such as those taking part in the trial, are not in a position to provide comprehensive data sets. The aim of the new approach is to provide small-scale and data-deficient fisheries with an alternative route to certification against the MSC's standard, while maintaining the scientific rigour that characterises the MSC programme.

In May 2007, the MSC Technical Advisory Board approved the draft methodological guidance for use in a number of trial fisheries assessments which will be conducted by third party certifiers. The aim of the trials is to allow for practical testing, reviewing and evaluation of the guidance methodology to ensure its effectiveness.

The benefits of MSC certification to the fishing industry, retailers, wholesalers and consumers are as follows:

- **Fishing industry:** Recognition of good and heightened management of fisheries, preferred supplier status, newer markets
- **Retailers and wholesalers:** Commitment to sustainability, confidence in sustainability of product, meeting consumer demand
- **Consumers:** Not contributing towards overfishing and ecosystem degradation and supporting the management efforts

MSC Certification and World Wide Fund for Nature

Since its inception in 1961, WWF has invested in more than 100 countries to protect the world's oceans by reducing pollution on land and sea, ending destructive fishing practices, creating new and improving management of marine protected areas, and curtailing illegal trade in marine wildlife. Since 1999, WWF has taken a special interest in applying Marine Stewardship Council certification as a conservation tool in small-scale fisheries. With the strength of our global network and partnerships with local NGOs, WWF is well equipped to facilitate MSC certification of fisheries in both developing and developed countries.

Pre analysis model is one of the creative tools for assessing the fisheries and select the best candidate species for certification. As a maiden attempt towards MSC Certification WWF - India with support from Sustainable Fisheries Fund began the process of MSC certification in India.

Community based MSC certification in India

Nearly 85% of fisheries in India are contributed by the artisanal/small scale sector. Historically artisanal fisheries has been stable than mechanized sector, however recent trends show that due to unsuitable fishing methods, the catches have declined and resulted in extensive damage to the ecosystem. As artisanal fisheries are community based and adoption of community based management of fisheries in India represents a significant milestone towards management and improving stocks of fishes. WWF's Community Based Certification programme can help small scale fisheries through the Marine Stewardship Council (MSC) certification process. WWF's Community Fisheries Programme has grown and includes over 15 projects worldwide and with WWF's global network of organisations and its partnership with local NGO's, the Community Fisheries Programme is well equipped to facilitate MSC certification of small scale fisheries in both developed and developing countries. This has shown great success in a few short years.

On the matrix of labeling eco-friendly fishery and fishery practice, a survey was conducted to identify ecologically sustainable fishing practice in the coastal zones of West Bengal, Kerala, Gujarat and Tamil Nadu. The objective of the project was to identify community-based fisheries from the different states of India that are ecologically sustainable with respect to their catch, culture, crafts and gears, community participation, and environmental. Through the pre-analysis process the Community Based Certification (CBC) methodology was effectively and efficiently tested over a large area for identifying the most promising candidates for certification in the region. Moreover, pre-analysis also offers a way to create a regional plan for fisheries certification or can be used as a piece of a more broad conservation strategy where MSC certification is used as one tool among many.

This project identified potential candidates for MSC certification as well as increased stakeholder awareness about fisheries conservation and MSC certification. The pre-analysis report recommended moving forward with pre-assessments with the oil sardine (*Sardinella longiceps*) fishery and a squid (*Doryteuthis sibogae*) fishery, both located in Kerala. Further to this Short Neck clam Fishery (*Paphia malabarica*) of Ashtamudi estuary was also considered for MSC certification and a pre assessment was carried out for this resource.

The pre assessment recommended that the oil sardine and squid fishery does not proceed into MSC full assessment at this time due to several significant issues that cause the fisheries to fall short of the MSC standard. In the oil sardine fishery, the main issues were:

- Management system does not link scientific information about the fishery to appropriate management actions like harvest control rules and reference points for the stock
- No clear research plans or system of management performance evaluation is in place to inform management objectives and strategies.

In this context a Fishery Improvement Plan (FIP) addressing these issues were developed to move the fisheries towards full certification.

The pre assessment of the Ashtamudi Short Neck Clam fishery was conducted in March 2010. The assessment body commented that the fishery is fundamentally in good shape. The stock appears to be strong, the species is fecund and fast growing, the harvesting methods are restricted to manual gathering and thus highly likely to be sustainable and the effects of the fishery on the marine environment appear to be minimal, again because of the low-intensity gathering methods required by the management regime.

The fishery's weaknesses lie in a lack of information and documentation in some key areas. These shortcomings could be swiftly addressed by drawing up management and information gathering strategies to cover these key areas, which include the following:-

- Management and monitoring of possible effects of the fishery on habitats
- Management and monitoring of possible effects of the fishery on ecosystems
- Long term objectives for the stock and for the fishery
- Evidence of the system (governing council) in place for stakeholder engagement in decision-taking

The MSC full assessment of the clam fishery was completed in Oct'2013 and would be the first fishery to gain MSC certification in India.

Conclusion

Presently, the concept of fisheries certification/eco - labeling is becoming conventional in fisheries. The review of developments in the certified fisheries and the rise in the number of certified fisheries over the past five to six years indicates that it can play a vital role in reversing the declining trend in the fisheries resources and also as a conservation tool.

Reference

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Responsible Fisheries Management in India – A Legal Perspective

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Introduction

Today it has become increasingly apparent that conservation of marine living resources presents much more complex problems of regulation and management than hitherto envisaged during the centuries over which they have been exploited by humans. From the use of rod and line and small boats operating close inshore with sisal nets and taking fish mainly for human consumption locally, developed sections of the industry have progressed to the use of sonar and satellites for locating fish shoals, and factory/freezer vessels which can store and process fish on board and stay at sea for months at a time, operating in large fleets.

Legal instruments play an important role in ensuring and facilitating the conservation and management of fisheries resources. This paper attempts to give an overview of the important international and Indian legal instruments that relate to the subject of responsible fisheries management. The international legal instruments would provide a background of India's obligations with respect to ensuring the conservation and management of fisheries resources and the discussion of Indian position would provide an overview of the state of the law in India and the vacuum that exists in the legal framework.

The International legal framework

International law on the management of marine living resources has developed on an ad hoc basis with little, if any, of the coordination and integration required for effective conservation or the assurance that it will be based on scientific advice. Though the oceans are an ecosystem or a series of interlocking ecosystems, legally they have been divided into jurisdictional zones.

The 1982 *United Nations Convention on the Law of the Sea* is the foundation for the modern law relating to international fisheries. The 1982 UNCLOS was an important step forward with respect to attribution of jurisdiction over conservation and use of marine

living resources. Article 3 of UNCLOS establishes a twelve-mile limit for the territorial sea over which the coastal state has sovereignty, subject to any requirement of the UNCLOS and other rules of international law. Foreign fishing vessels are required to refrain from fishing activities in the territorial sea [See Articles 19 (2) (i) & 42 (1) (c)]. The coastal state can adopt *laws and regulations*, consistent with UNCLOS and other international rules, to prevent infringement of its fishery laws (emphasis added) [See Article 21 (1) (e)]

By establishing the Exclusive Economic Zone (EEZ) in an area not exceeding 200 nautical-mile from the low-water baseline of the territorial sea the UNCLOS negotiators sought to provide a more effective basis for conservation and sustainable management of marine living resources. The EEZ is not an area in which the coastal state has territorial sovereignty. It is a more limited functional zone in which the coastal state is accorded sovereign rights for the purpose of exploring, exploiting, conserving and managing the natural resources, whether living or non-living, of the water superjacent to the seabed and its subsoil. [Article 56 (1) (a)]. The coastal state can also exercise jurisdiction with respect to scientific research and protection and preservation of the marine environment. [Article 56 (1) (b) & (c)]. Coastal states are required to give 'due regard' to the rights and duties of other states and the actions of the coastal states are to be compatible with UNCLOS. The fish within the EEZ zone thus ceases to be common property. Although other states may in certain circumstances have a claim to share in EEZ fishing [Articles 62 (2), 69 & 70], the coastal state determines the total allowable catch (TAC) for harvesting the living resources and allocates fishing rights [Article 61 (1)].

Thus though the coastal state has the sovereign right to exploit the EEZ living resources this right is qualified by the conservatory obligations laid down in UNCLOS [Article 61].

It is clearly important for conservation of high seas and EEZ fisheries that states implement in good faith a conservatory and management regime based on the principles and considerations set out in 1982 UNCLOS.

The 1982 UNCLOS recognises that all states have the right for their nationals to engage in fishing on the *high seas*. This right is however subject to existing treaty obligations and the rights and duties of coastal states in conserving stocks that migrate between EEZs and the high seas. [Articles 63 – 67]. Article 117 lays down the duty of states to take, or to cooperate with other states in taking, the measures for their nationals that may be necessary to conserve high-seas living resources. This obligation also extends to marine mammals [Article 120] The UNCLOS does not lay down any harmonised standards for conservation of fish stocks on the high seas. Article 63 (2) of UNCLOS obliges coastal states and states fishing beyond EEZs to seek 'to agree on the measures necessary to co-ordinate and ensure the conservation and development of such stocks'. They are allowed to do this either directly or through appropriate regional or sub-regional organisations. Article 118 also spells out the duty to cooperate in the management of high-seas fisheries and requires that states exploiting the same resources or resources in the same area 'enter into negotiations with a view to taking measures necessary for conservation'. States are also required to

cooperate in establishing regional and sub-regional fisheries organisations for this purpose. Article 199 specifies the factors that states must take into consideration in determining the total allowable catch (TAC) and other conservation measures for the high seas.

Notwithstanding the widespread adoption of the 200 mile EEZ, the over-exploitation of fish stocks shows that the UNCLOS strategy for sustainable fishing has not worked as intended. One reason for this failure is that some coastal states have failed to ensure sustainable fishing within their own EEZ. The short-term national interests of some states have tempted them to give more weight to the economic than environmental considerations. There does not exist any effective mechanism to hold states accountable for the management and conservation of fish stocks within their own territorial sea or EEZ. Another closely connected problem is that some important fish stocks are not confined to EEZ but can also be taken on the High Seas. Redrawing the boundaries between coastal state jurisdiction and the high seas has not done away with the unavoidable facts of geography. Thus most fish are inevitable a shared EEZ resource and are in some cases also a high seas common property resource.

The 1995 *United Nations Fish Stocks Agreement* builds on the existing provisions of the 1982 UNCLOS and thereby attempts to deal with the serious problem of sustainable fishing. The 195 Agreement applies only to straddling and high migratory fish stocks in areas beyond national jurisdiction – i.e., on the high seas. It introduces new obligations of sustainable use, requires a precautionary approach to be applied to the conservation and management of stocks and broadens this obligation to include associated ecosystems. It also seeks to ensure compatibility between EEZ and high seas conservation measures and places on parties a more extensive obligation to cooperate through regional fisheries bodies, without which they risk losing the right to fish on the high seas. The 1995 Agreement retains the wording of Article 119 of UNCLOS 1982, but places maximum sustainable yield within the context of a proactive, precautionary and more environmentally focussed approach to conservation and sustainable use. [Articles 5 & 6 of 1995 Agreement]. The 1995 Agreement requires states to apply a precautionary approach to fishing and to the protection of associated ecosystems and species. The Agreement recognises that its objectives can only be achieved through improved regional cooperation between coastal and distant water fishing states. Article 8 of the 1995 Agreement spells out the duty of all states fishing on high seas to cooperate in order to ‘ensure effective conservation and management of such stocks’. They can do this either directly or through regional fisheries management organisations (RFMOs). The 1995 Agreement goes one step further and lays down the functions of these bodies. One of the main elements of the 1995 Agreement is to ensure that the measures taken for conservation and management in the EEZ and in the adjacent high seas are compatible and coherent. Article 7 of the 1995 Agreement thus amplifies Articles 63 and 64 of 1982 UNCLOS by requiring states to cooperate to ensure compatibility between the measures adopted for high-seas areas and those for areas under national jurisdiction (i.e., EEZ). The 1995 Agreement has also laid down a new enforcement and compliance regime for high seas fishing. *Flag State regulatory and enforcement responsibility* is expressed in more specific terms in the 1995 Agreement (emphasis added).

The Agreement to Promote Compliance With International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement) was adopted under auspices of the Food and Agricultural Organisation (FAO) in 1993. It was adopted as part of FAO's work on the Code of Conduct for Responsible Fisheries (CCRF) and was formally integrated as part of CCRF when the Code was adopted in 1995. The FAO Compliance Agreement contains a number of provisions of considerable importance to high seas fisheries management. It was the first instrument to develop the principle of flag state responsibility on a global scale. The Agreement applies in general to all fishing vessels that are used or intended for fishing in the high seas. Provision is made, however, for State Parties to exempt vessels of less than 24 metres in length from the application of the Agreement. The Agreement also contains several provisions which seek to ensure free flow of information on high seas fishing activities.

The *FAO Code of Conduct on Responsible Fisheries (CCRF)*, 1995 is a non-binding instrument which sets out principles and international standards of behaviour for responsible practices designed to ensure effective conservation, management and development of living aquatic resources. The leading objective of the CCRF is to establish principles for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, economic, social, environmental and commercial aspects. The CCRF also attempts to lay down principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development. It is also intended to serve as an instrument of reference which may help states to establish / improve legal and institutional framework required for the exercise of responsible fisheries. The Code requires States to prevent over fishing and excess fishing capacity and also to implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilisation. Conservation and management decisions are to be based on best scientific evidence available. These decisions shall also take into account traditional knowledge of the resources and their habitat, as well as relevant environmental, economic and social factors. The States and sub-regional and regional fisheries management organisations are urged to apply a precautionary approach when it comes to conservation, management and exploitation of living aquatic resources.

Article 7 of CCF specifically deals with fisheries management. Article 7.1.1. of the Code requires States and all those engaged in fisheries management to adopt measures for the long term conservation and sustainable use of fisheries resources. This is to be done within the overall context of an appropriate policy, *legal* and institutional framework (emphasis added). It is pertinent to point out here that Article 7.1.2. of CCRF requires States to identify relevant domestic parties having a legitimate interest in the use and management of fisheries resources and establish arrangements for consulting them to gain their collaboration in achieving responsible fisheries. States and subregional or regional fisheries management organisations are required to ensure transparency in the mechanisms for fisheries management and also in the related decision-making process.[Article 7.1.9]They are also required to give due publicity to conservation and management measures. Laws,

rules and regulations governing the implementation of conservation and management measures are to be effectively disseminated among all stakeholders. [Article 7.1.10]

The Indian scenario

India declared a 200 mile Exclusive Economic Zone on the Indian Ocean by enacting the Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones Act, 1976 thereby earning the exclusive rights to exploit the living and non-living resources in this area comprising of 2.02 million sq. kilometres. This 1976 Act was enacted six years prior to the adoption of 1982 UNCLOS. The demarcation of maritime boundaries under the 1976 Act is similar to that in the 1982 UNCLOS.

As per the Indian Constitutional Scheme “Fishing and Fisheries Beyond Territorial Waters” is a Union Subject [Entry 57 of List I of VII Schedule of Constitution of India] and “Fisheries” is a State Subject [Entry 21 of List II]. In accordance with this Constitutional Scheme various states in India have enacted independent state legislations which are generally known as Marine Fishing Regulation Acts. These legislations have been enacted with the broad objective of regulating the fishing by fishing vessels in the sea along the coastline of the respective state. Though they have several limitations and deficiencies these state specific Marine Fishing Regulation Acts establish various frameworks to facilitate conservation and management of fisheries resources in the territorial waters.

For example under the Kerala Marine Fishing Regulation Act, 1980 empowers the State Government to regulate, restrict or prohibit the fishing in any specified area by such class or classes of fishing vessels as may be prescribed by the government. The Government is also empowered to regulate, restrict or prohibit the number of fishing vessels which may be used for fishing in any specified area. Restrictions can also be imposed with respect to certain specific species of fish and also with respect to use of specific types of fishing gears in specific areas. [Section 4 of KMFRA 1980]. One of main considerations on the basis of which the above restrictions can be imposed is the *need to conserve fish and to regulate fishing on a scientific basis* (emphasis added). The Act also establishes an institutional framework for licensing and registration of fishing vessels. It lays down mechanisms for enforcement of the various restrictions and prohibitions imposed by the provisions of the Act.

The only Indian fisheries specific legislation that applies to the Exclusive Economic Zone (EEZ) area is the Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act, 1981. This legislation was enacted to regulate fishing by foreign vessels in the Maritime Zones of India and for matters connected with it. As per the scheme of the Act a foreign fishing vessel which intends to fish in the Maritime Zones of India has to obtain necessary licence or letter of authorisation from the Central Government. The Central Government can impose various conditions in connection with issuance of license or authorisation.

Very recently in January 2013 the Department of Animal Husbandry, Diaring and Fisheries of the Ministry of Agriculture, Govt. of India notified the *Guidelines for Fishing Operations in the Indian Exclusive Economic Zone*. The Guidelines are binding on all deep sea fishing vessels operating in the Indian EEZ. The Guidelines aim to achieve sustainability in the operation of deep sea vessels in Indian EEZ. Compliance With the CCRF, Indian Ocean

Tuna Commission (IOTC) and other international rules and regulations in the management of fish stocks in the EEZ are also ensured by the Guidelines.

The above analysis reveals that there is a vacuum in the domestic legal framework governing the conservation and management of fisheries resources more particularly in the areas falling within the Exclusive Economic Zone (EEZ). Furthermore India needs to also address the issues relating to conservation and management of fisheries resources in the High Seas particularly with respect to vessels flying its flag and are engaged in High Seas Fisheries.

“Let’s get property rights right for responsible fisheries management”

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Responsible fisheries management will happen only when the property rights to the resources of the sea are bestowed on the right people – i.e. those who labour to harvest it. Once these rights are conferred on them, they will be in a position to be equal partners with the state and other stakeholders who may also have legitimate property rights to the resources and the territory of the sea/river/lake. The essence of negotiating responsible fisheries management therefore lies in having a clear understanding of property and rights – getting the rights right!

In this lecture, the effort is to take a step by step approach to explain the concepts of rights, property, and also clearing up some of the common confusions over the differences between different kinds of property rights. The most important clarification is to make the distinction between ‘property rights’ and ‘possession rights’. For property rights to exist there must be a triad of essentials: (1) the claimant; (2) the benefit stream being claimed; (3) and the others who will stand by the claim of the claimant. If only the first two are in place then only ‘possession rights’ prevail. This is a context of ‘open access’ where anyone can enter and possess what s/he wishes to take. There is an often heard statement “Everybody’s property is nobody’s property”. This is a false statement. The correct version is: “Everybody’s possession is nobody’s property”.

In the lecture the different kinds of property rights are described. Particular emphasis is given to the often misunderstood “common property rights”. Common property rights are nothing but the “private property rights” of a group. It is NOT a context of open access.

Before the advent of modern fisheries development, there were many forms of common or community property rights which prevailed in the coastal fishing communities.

These were socially sanctioned claims of fishers to the marine resources. Fishing communities devised different rules and norms about the use of these rights -- the nature of technology to be used; the times when fishing can be undertaken; the way outputs should be distributed; the manner of settling disputes and so forth.

With the advent of modern fisheries development, these original community property rights were not acknowledged, and the proclamation of state property rights over these resources created a context where the coastal waters became virtually open access because of the lack of proper regulation. Anyone could enter and take 'possession' of fishery resources. This was the beginning of the marginalisation of fishing communities. Along with disregard for their rights, the state also introduced technologies which were not appropriate to the tropical marine ecosystem. This led to the degradation of the ecosystem.

The only way out of this unsustainable ecological and socio-economic situation is to give back the rights to the fishers. First, this implies policies backed by actions for regulating the prevailing open access context. It will also require an aquarian reform package favouring the labouring fishworkers and the willingness of the state to co-manage the resources with them.

These are important and necessary steps if we are to move towards responsible fisheries and sustainable management for the good of the whole society.

Co-management Paradigm and Sociological issues in RFM in Indian Marine Fisheries Sector

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The open access regime existing in the harvesting of marine fishery resources in our country warrants stronger emphasis on invoking technological innovations as well as management paradigms that reconcile livelihood issues with concerns on resource conservation. Innovations do not happen in a socio-political vacuum. It is the extent of partnership between the research and the client system that decides the fate of any technology in terms of its adoption or rejection. Rational utilization of common property resources for sustainable development without endangering the environment is possible through community participation. For more than 6 million fishers and fish farmers, fisheries are a source of livelihood in India. Fisheries sector has recorded faster growth as compared to the agricultural sector in all the decades and is contributing in a significant way to the economic growth of the nation. The vast Exclusive Economic Zone of 2.02 million sq. km of ocean under the possession of India is more than two third of its land area. Marine fishing has been considered as a primary livelihood option since time immemorial, for the occupants of the coastal belt in India. The marine fishery resources of the country include a coastline of 8129 km with numerous creeks and saline water areas, an Exclusive Economic Zone (EEZ) of 2.02 million km² which are suitable for capture as well as culture fisheries. The annual harvestable marine fishery resources in the Indian EEZ have been estimated at about 3.93 million tonnes constituting more than 50% demersal, 43 % pelagic and 6% oceanic groups. (Rao Syda, 2011) Moreover it supports the deprived coastal community with sufficient nutritional security which is otherwise unreachable for such segment. Currently the marine fisheries sector produces about 2.6 million tonnes (2003) of fish per annum. About 3 million people are employed in the primary, secondary and tertiary sector of marine fisheries which provides livelihood security to about 18 to 20 million people. (Sathiadhas, 2007)

Fisheries development is a state subject in India, but, centre promotes fisheries development through state level programme planning and implementation units. The development plans for the fisheries sector have been aiming at fish production and promoting export. India is blessed with vast and varied fishery resources with great

potential in both coastal and inland areas. But, fisheries production is showing a depleting trend which is adversely affecting the livelihoods of fishers and making a large population vulnerable. Being the open access resource, stock assessment and irreplaceable nature of abundance in stock, conflicts of various types become the part and parcel of the fisheries system in the country. To address the livelihood issue, government introduced regulatory mechanisms such as gear selectivity, seasonal area closures and regulations that control the fishing effort and catching. This is 'top down government driven management approach' through legislation. However, government managed models of management have proved to be unsuccessful as indicated by poor compliance of action and regulations resulting in crisis and adverse affects on the livelihood of fishers.

Conflicts in Capture Fisheries Sector: Marine & Inland fisheries

With regard to conflicts in capture fisheries sector, there are marine and inland fisheries sectors to be considered. In marine sector, each country has their jurisdiction up to 200Nm towards sea. In India concept of Exclusive Economic Zone (EEZ) enacted during 1997. In dealing with management, protection and proper utilisation of living marine resources several conflicts has been raised.

Conflicts between India and neighbouring countries: Some examples

- Primarily arises from fishermen's violations of national jurisdiction while in the pursuit of fish. Fishermen are lacking navigational devices which can forewarn fisherman from trespassing their jurisdiction.
- Political problem between India-Pakistan and Tamil problem causing tensions between India-Sri Lanka.
- Fishermen in Okha in Gujarat accidentally trespassing Indian jurisdiction being caught by Pak navy patrols.
- Fishermen in Rameshwaram in T.N. being caught by Sri Lankan navy.
- Conflicts over marine fisheries India and Bangladesh are rather rare.

Conflicts between states : Some examples

Conflicts occur mainly between southwestern states and south eastern states. (Goa, Tamil Nadu, Karnataka, Kerala.) It essentially is because of differential fishing ban period during monsoon. There is no demarked boundary between states in the marine region. (Each state has their jurisdiction up to 12 nm towards sea)

Conflicts between fishermen using two levels of technology

- Large scale industrial fishing vessel and small scale fishing vessel.
- Inshore and deep sea fishing vessel.
- Trawlers and Purse-seiners.

Today there seems to be change in the direction of conflicts.

Regional conflicts between fishermen

- Between fishermen from one state to the other.
- Between fishermen from one harbour to the other.

Conflicts between fishermen and industries: Example: Mangalore coast is conspicuously noted for conflicts of fisherfolk with industries.

Inland Fisheries: accounted the conflicts in reservoir fisheries and riverine fisheries.

Culture Fisheries Sector (Aquaculture)

Social conflicts and aquaculture

Conflicts between the shrimp farmers and fishermen

The shrimp farms do not provide access to the beach for traditional fishermen who have to reach the sea from the village.

A typology of fishery conflicts

In most fisheries, there appears to be little space available to increase long-term sustainable fishery benefits simply by increasing production. The fishery policy tools are generally limited to

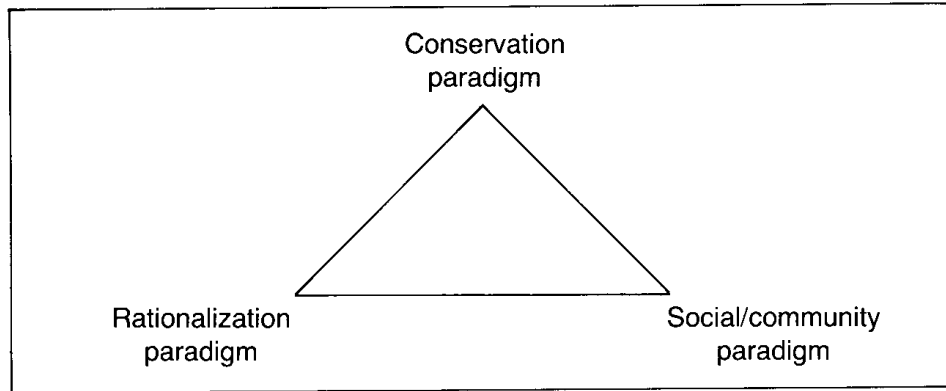
- 1) Increasing the efficiency of harvesting and of management
- 2) Making allocation (distributing) decisions, particularly determining who has the privilege of access to the fish available for capture.

Despite superficial appearances of chaos, the wide range of fishery conflicts (of both the efficiency and allocation varieties) can be organized into a relatively small number of categories, under for inter-related headings.

- (1) Fishery Jurisdiction: Involving fundamental conflicts over the who 'owns' the fishery, who controls, access to it, has is the optimal form of fishery management, and what should be the role played by governments in the fishery system.
- (2) Management mechanisms: concerning relatively short-term issues arising in the development and implementation of fishery management plans, typically involving fishers/ governments in the fishery system.
- (3) Internal allocation: involving conflicts arising within the specific fishery system, between different user groups and rear types, as well as between fishers, processors and other players.
- (4) External allocation: incorporating the wide range of conflicts arising between internal fishery players and outsiders, including foreign fleets, aquaculturists, non-fish industries (such as tourism and forestry) and indeed the public at large.

Conflicting fishery paradigms:

While the above typology categorises fishery conflicts, the real roots of the conflicts which lie in the underlying systematic differences in priorities pursued by the various fisheries players are to be given prime consideration. For example, everyone wants their fishery to be efficient, but the real meaning of this pleasant-sounding goal depends entirely on the desired objectives which in turn vary widely with the philosophy and ideology of the fishery players.



Conflicts and wars related to the rights over the use of land and water have been important human issues throughout recorded history. Although many of us are probably more aware of wars fought over religious freedom, political ideologies and social issues, conflicts over fishing rights and resources are just as common, if less reported. Since the Exclusive Economic Zones (EEZ) were established in the 1970s, disputes have become more frequent and more violent than ever before. Due to the establishment of EEZs, access to the world's oceans has been radically reorganized and the access rights of foreign fishing vessels have been curtailed. Negotiations, international fisheries agreements (such as those between European and African countries), and recourse to an international tribunal have sometimes succeeded in resolving conflicts.

Conflict between Philippines and China is essentially due to over access to territorial waters. Thousands of Indonesian fishers have been incarcerated as a result of illegal fishing in Australian waters. While sovereignty issues are generally at the root of such conflicts, they are also the manifestation of competition for access to fish stocks, in coastal waters as much as on the high seas. In addition, the use of flags of convenience serves to exacerbate the problem. The country where a boat is registered does not necessarily identify its country of origin, and this loophole enables fishing companies to flout international fishing and labor conventions with impunity.

Paradigm shift in fisheries governance

There is an extreme necessity to have a paradigm shift in governance of fisheries which enables resource users (communities and fishers) and stakeholders' participation at all levels as effective partners in the management process. Management regimes as remedy cover Partnerships, Co-operation, Leasing (Aquaculture) and Co-management paradigms.

Partnership and Co-operations through Fisheries co-operatives and Self Help Groups mobilized in marine fisheries sector do play a vital role in sustainable fisheries management. (Vipinkumar, 2012). Leasing essentially occurs with regard to aquaculture sector. Let's have a look into the policy and programmes for aquaculture development in India.

The registration of open water body farms and government leasing determines the appropriate areas for Mariculture activity, allocating the rights to use the resource and

evaluation of environmental impacts based on certain principles to be considered to frame the Mariculture policy. (Mohamed and Kripa, 2010)

1. Common Property use conflicts: Policy guided by: Use of open water bodies for navigation and fishing should not be hindered by Mariculture. Similarly, Mariculture activities in open water bodies should not cause disturbances to other users. Permitted Mariculture by the state should be afforded complete protection of structure and stock kept in the open water bodies.
2. Carrying capacity: Open water bodies have limits to biological productions and such limits should be defined by the state in consultation with research institutions.
3. Environmental Protection: The polluter pays principle enacted by the CAAI should be applicable to pen water bodies so as to minimise environmental impacts. Pre and Post EIA (Environmental Impact Assessment) is mandatory.
4. Conservation: Aquatic ecosystems are very sensitive to changes caused by human activities and hence all activities should take into consideration conservation of aquatic biodiversity.
5. Zonation: Since Mariculture in open water bodies diverse and region specific, states have to draw-up zonation plans in GIS formats with the help research institutions. Creation of Mariculture parks should be encouraged.

Partnerships and Co-management Paradigms

There are success stories in Asia pacific region where the alternative models have been able to take care of all the parameters of sustainability. One of such fisheries management approaches, as an alternative to the top down government management approach is 'co-management'. This is a partnership arrangement in which the community of local resource users (fishers), government and other stakeholders share the responsibility and authority for the management of fisheries through consultations and negotiations as regards to their roles, responsibilities and rights resulting in development of effective partnerships. This ensures sustainability of the resources as well as improving the livelihood of fishers.

Fisheries Co-management

Fisheries co-management is defined as an arrangement where responsibility for resource management is shared between the government and user groups (Nielson *et al*, 2004). It is considered to be one solution to the growing problems of resource over-exploitation. If the regime is both to be effective and legitimate, introducing a co-management arrangement, which can be defined as a dynamic partnership using the capacity and interest of user-groups complemented by the ability of the fisheries administration to provide enabling legislation? Co-management is also a mean to reorganizing the fisheries management system. Co-management is - from this perspective - an institutional process of integrating and reallocating management responsibilities and competence (legal power) among participants by sharing the costs deriving from fisheries management with the users. Fisheries co-management is based on the following hypothesis. The involvement and participation of user-groups create incentives for cooperation in order to formulate and implement more efficient, equal and sustainable management schemes which would benefit all parties.

Co-management provides some sense of ownership to the fish resources, which makes the user groups far more responsible for obtaining long-term sustainability of the fish resources. It might also be more cost-efficient in terms of administration. Enforcement than centralized systems, but administration costs may increase in a co-management system, as the process may be rather time consuming, involving several interest groups.

Co-management is often referred to as relations between fishermen and the national administration including fisheries research institutions, mainly concerning regulation methods, quota allocation and stock assessment. However, co-management can also be perceived in relation to market activities, whereby relations between fishermen and buyers come in focus. As market dynamics become more important to fishing activities, it can be expected that coordination of market performance and fisheries management measures will be increasingly important.

Co-management is a set of institutional and organizational arrangements (rights and rules), which determine how the fisheries administration and user-groups cooperate. A co-management arrangement is not a static legal structure of rights and rules, but a dynamic process of creating new institutional structures. A co-management institution can therefore be designed as an entirely new institution or can be based on already established institutional structures. The latter might often be the case in fisheries, where co-management institutions usually evolve as incremental user-group involvement in certain management tasks. The devolution of authority to manage the fisheries, away from the fisheries administration to user-groups, may be one of the most difficult tasks of co-management. On the one hand, the fisheries administration may be reluctant to relinquish their authority, or portions of it, and are often opposed to decentralization. On the other hand, user-groups may neither have the aspiration nor the capabilities to undertake enhanced fisheries management responsibilities.

Advantages of approaching fisheries management as a bottom-up process versus the traditional centralized top-down system may be a high degree of acceptability and compliance with regulation measures, due to the participation of user-groups in the decision-making and implementation process. Once user groups are involved in the decision making and implementation of fisheries management, a spectrum of co-management arrangements can be identified. The figures illustrate the various types of institutional set-up for different co-management arrangements.

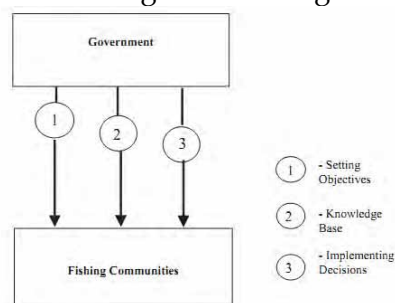


Fig. 1. Modern fisheries management.

In the instructive type, there is only minimal exchange of information between government and users. This type of co-management regime is only different from centralized management in the sense that the mechanisms exist for dialogue with users, but the process itself tends to be government informing users on the decisions they plan to make.

Co-management can be an innovative change to the modern fisheries management approach as it implies a power sharing arrangement between government and fishing communities to undertake fisheries management. However, the practical adaptation by governments of the co-management approach has most often been limited to involving fishing communities in the implementation process—an ‘instrumental co-management’ approach

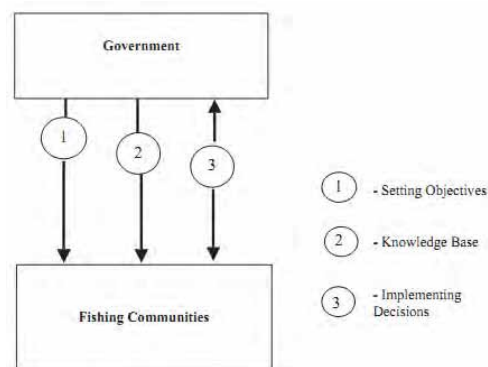


Fig. 2. Instrumental co-management.

Socio-economic considerations are likely to play a more prominent role within an empowering co-management arrangement. Empowerment of fishing communities is a mechanism to give the people within the fishing communities a chance to influence their own future in order to cope with the impact from globalisation; competing use of freshwater and coastal environments; and other fisheries related issues.

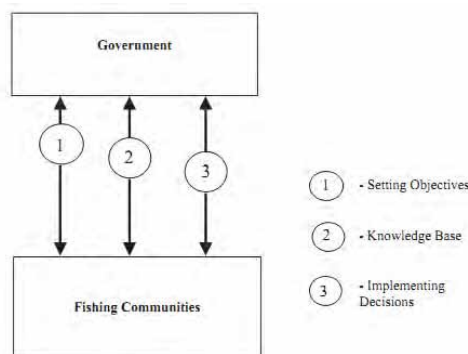


Fig. 3. Empowering fisheries co-management.

The empowering co-management approach is a demanding concept, as it requires:

- A rethink of the logic for management and subsequently a change in the knowledge base for management.
- A major restructuring of the institutional and organisational arrangements supporting management.
- A substantial change in attitudes from both governments and fishing communities towards their role in such arrangements.
- Aspiration from fishing communities and government to proceed along this avenue.
- Capacity building at several levels both within government and fishing communities.

Co-management for Fisheries Conservation and Livelihood

- Competitive Fishing needs to be replaced by cooperative fishing to avoid depletion and ultimate extinction of several varieties of our marine flora and fauna.
- Fishery resources are renewable but not inexhaustible.
- Cooperative fishing minimizes capital investment vis-à-vis cost of production, sustainability of resources and maximizes the earnings and profit.
- Cooperative marketing enhances the efficiency of distribution channel and enhances the earnings of real producers.

Common property: Management issues

- Common property means, no one is having ownership: hence no – management
- The literature on property rights identifies different ideal analytical types of property rights regimes:
- State property: with sole government jurisdiction and centralized regulatory controls;
- Private property: with privatization of rights through the establishment of individual or Company-held ownership

Co- management: Theoretical Framework

- Co- management is a new alternative management approach with a human face.
- Co-management is an effective process for the collective governance of common property resources.
- Co-operative management or co-management of fisheries can be defined as a partnership arrangement in which the community of local resource users (fishers), government, other stakeholders (boat owners, fish traders, boat builders, business people, etc.) and external agents (non-governmental organizations (NGOs), academic and research institutions) share the responsibility and authority for the management of the fishery.
- The substance of sharing of responsibility and authority will be negotiated between community members and government and be within the boundaries of government policy.

- The term 'community' can have several meanings. Community can be defined geographically by political or resource boundaries or socially as a community of individuals with common interests.

A community is not necessarily a village, and a village is not necessarily a community. Care should also be taken not to assume that a community is a homogeneous unit, as there will often be different interests in a community, based on gender, class, ethnic and economic variations.

Co-management should be viewed not as a single strategy to solve all problems of fisheries management, but rather as a process of resource management, maturing, adjusting and adapting to changing conditions over time. A healthy co-management process will change over time in response to changes in the level of trust, credibility, legitimacy and success of the partners and the whole co-management arrangement.

- Co-management is also called participatory, joint, stakeholder, multi-party or collaborative management.
- Co-management sharing and decentralization. It attempts to overcome the distrust, corruption, involves aspects of democratization, social empowerment, power fragmentation and inefficiency of existing fisheries management arrangements through collaboration
- Partnerships, roles and responsibilities are pursued, strengthened and redefined at different times in the co-management process, depending on the needs and opportunities
- The process may include formal and or informal organizations of fishers and other stakeholders.
- Fisheries co-management can be classified into five broad types according to the roles government and fishers play (Sen and Nielsen, 1996):
 - (1)*Instructive*: There is only minimal exchange of information between government and fishers. This type of co-management regime is only different from centralized management in the sense that the mechanisms exist for dialogue with users, but the process itself tends to be government informing fishers on the decisions they plan to make.
 - (2)*Consultative*: Mechanisms exist for government to consult with fishers but all decisions are taken by government.
 - (3)*Cooperative*: This type of co-management is where government and fishers cooperate together as equal partners in decision-making.
 - (4)*Advisory*: Fishers advise government of decisions to be taken and government endorses these decisions.
 - (5)*Informative*: Government has delegated authority to make decisions to fisher groups who are responsible for informing government of these decisions.

Through co-management, equity and social justice in fisheries management is sought. Equity and social justice is brought about through empowerment and active participation in the planning and implementation of fisheries co-management. The mutuality of interests and the sharing of responsibility among and between partners will help to narrow the distance between resource managers and fishers, bringing about closer compatibility of the objectives of management.

- The overall prospects for co-management are good in the Philippines, Cambodia, Indonesia, Thailand, Vietnam, Laos, Bangladesh, India, Malaysia, Sri Lanka, Mozambique, Zambia, South Africa, Malawi and Kenya.

The Stakeholder analysis

Other than fishers, stakeholders (individuals, groups or organizations who are in one way or another interested, involved or affected (positively or negatively) by a particular action) that derive economic benefit from the resource (for example, boat owners, fish traders, business suppliers, police, politicians, consumers) should also be considered in co-management and the stakeholder analysis can help to identify those stakeholders who should be included in co-management.

A Case study of Co-management in Indian context

There has been an interesting sharing of ideas in recent issues of *SAMUDRA Report* on the experiences and principles of co-management. All over the world, fisher communities are trying desperately to safeguard their access to fish resources, while, at the same time, being driven to catch more in order to keep afloat. The fishers of the Saurashtra coast of Gujarat, one of the foremost fish-producing States of India, are no exception, as a result of the study undertaken on “The Impact of Development on Human Population Dynamics and the Ecosystem” in three locations of the west coast of India, with the help of a grant from the McArthur Foundation.

One of the study locations was the large fishing harbour town of Veraval in Gujarat. The findings of the study were rather revealing, not only regarding the nature of the decline of the overcapitalized trawl fishery, but also the poor environmental and social indicators in a place that had a booming fishery for over 25 years through the 1980s and 1990s. In the community feedback workshops held in 2005, people were also taken aback by the findings of the study for a while and they were aware that their fishery was on the downswing, they felt challenged to realize that a large number of the children of the community were not in school, that there was a fall in the female sex ratio, and that there was a rise in the levels of morbidity and demands for dowry at marriages. As a community that is basically business-oriented and with a desire to simultaneously claim progress, they found themselves in a prisoner’s dilemma. A challenge of seeking a way out by the project authorities made them interact with them on a longer-term basis.

The fishery in the area is a trawl fishery along a 40-km coastline between the two fishing harbours of Veraval and Mangrol, which account for a third of the fish catches of Gujarat. There is also a vibrant *hodi* fishery of fiberglass-reinforced plastic (FRP) beach-landing craft, interspersed with the trawlers. Authorities got intensively involved in the fishing harbour/community of Mangrol as the community has traditionally been well organized. They were also fortunate to get a local team that the local community agreed to host. In preparation for the work, an intensive training programme was organized for the team. There were also four representatives from Mangrol and Veraval, selected by the community, who participated in the programme. They actually represented the trawl fishery.

Initiating change

Project people did not initially mind this fact as it was this sector that they thought had to be involved in initiating any change in resource management. The boat owners were intensely involved in the training programme and, during the subsequent period, they turned out to be the main agents of change in the community. Besides developing an analysis of the fisheries crisis, they were most intrigued by the connections made to the fall in the female sex ratio, the number of school-age dropouts, the high morbidity rates, and the extensive pollution of water bodies, all in a context where the communities were well organized but totally in the hands of men. The inputs on gender analysis and the patriarchal development paradigm helped them to see the negative side of male-dominated communities, where women have no voice, and, as a consequence, the issues of potable water, sanitation and health receive no priority. In fact, the community organizations had seen to it that entry into the trawl fishery was limited to members of the same caste. Yet just as these caste organizations camouflaged disparities in the community, they were unable to manage the manner in which investments were made in the fishery, which, in turn, aggravated the growing disparities.

The fishery in the area has been kept afloat by, on the one hand, State subsidies on diesel and, on the other, by the opening up of export markets and the development of *surimi* plants. It is otherwise an extremely inefficiently run trawl fishery, which has also contributed to the massive pollution in the harbours. But the government has gradually begun to be less lenient on the diesel subsidies, certain export consignments have been rejected by some importing countries, and the government has begun giving greater importance to developing coastal resources other than fisheries. The fishing communities, therefore, needed to get their act together and think differently about their fishery and its future if they did continue to consider the fishery as a means of livelihood.

Strategies to tackle this problem were developed at the training programme, and a plan was drawn up to set up a coastal area managing council in a year as well as push for co-management of the fisheries. The first step was to develop a general awareness in the community about the inter-relationships among the ocean, the land and the people so that people understand how these affect one another. This was done at several levels through all kinds of community programmes but the strategy in the first year was to:

- develop a forum for women where they could discuss and understand these issues and, at the same time, create a collective to gradually represent their cause and themselves in the community organization (*samaj*);
- create an awareness among the youth and children about the coast and oceans; and
- widen the understanding of the fishers themselves regarding coastal-area issues, and relate these to their fisheries-management possibilities. For this, efforts were made to also include the elected representatives of the municipality in discussions related to these issues so that they would be taken into consideration in town planning.

The most interesting results were from an active group of women fish vendors who pressured the municipality and the fisheries department for a better fish market, while

another group made a detailed study of the community's problems relating to water, sanitation and attendant infrastructure, which was presented to the members of the *samaj*. In both these cases, the community's men were very responsive and open to the idea that women could also be part of the co-management process.

The discussions on co-management were done separately for the fishing sectors, the community organizations and the women so that all of them could understand the issues and felt free to raise doubts and make suggestions from the point of view of their own sectors. It was clear that there were several areas of conflict.

After the discussions, all the representatives got together to discuss the possibility of a larger plan and who would finally meet the government and scientists to make the proposed presentation on co-management. Importantly, it was the first time that women and men from various sectors, caste and religious groupings had got together to discuss coastal and fisheries issues.

Between 2 and 3 August 2007, an Expert Consultation on Fisheries and Area Co-management was held in Ahmedabad, the capital of Gujarat, supported by the Fish Code Programme of the Food and Agriculture Organization of the United Nations (FAO), where the State's entire fisheries department was present, together with scientists from the Central Marine Fisheries Institute (CMFRI), the Central Institute of Fisheries Technology (CIFT) and the Fisheries Survey of India (FSI), as well as trader, processor and non-governmental organizations (NGOs) and the Marine Products Export Development Authority (MPEDA).

The community leaders first presented their ideas on co-management, which included both the need for fisheries management and coastal-area management, and articulated why they thought that this was a viable option in their particular context.

They requested the government to create a framework of legislation for co-management, where both their rights to the coastal resources and the responsibilities of the government and the various stakeholders would be clearly defined. Subsequently, the experts responded, and a group discussion followed on the action that could be taken.

An interesting and heated discussion between the trawl-boat owners, the scientists and the government officials had even the women chipping in, but unfortunately the *hodi* owners remained silent.

The importance of this process has to do with the fact that co-management was proposed by the community representatives from a shore-based fisheries perspective and not a fishing perspective alone. This was possible because of the data available and the focus on the fishery as a means of livelihood that has to be sustained. But this is not an easy process and it still has to be operationalized. The bank on the tremendous amount of goodwill shown by all the stakeholders, indicates that the stakes in actually managing the fisheries are high.

Conflict resolution through Sui-generis co-management : A case study of Kadakkody in Kerala

Kadakkody: A linguistic aberration of the Malayalam word 'Kadal-kodathy' literally meaning 'Sea Court'. It has legislative, executive and judiciary roles to play in the Araya and Dheevara communities of Hindu fishermen belonging to Kasargod district of Kerala. Kadakkodies make their presence felt strongly in four regions like Kasargod, Kizhoor, Kottikkulam and Bakkalam. It plays as a community based fisheries management institution. Though functional only in a few pockets of north Malabar coast of Kerala, these age old institutions are similar to many of the Caste Panchayats prevalent in rural India. (Ramachandran, 2004).

Constitution of *kadakkody*: Each *kadakkody* is an adjunct to the temple of the fishermen community in each village. Ruling deity in all these temples is *Kurumba Bhagavathy* who is considered the most worshipped 'mother goddess' (Devi) among Hindu fisherfolk. Each *kadakkody* has three distinct bodies (1) Sthanikan (the permanently authorized), (2) *kadavanmar/Sahayies* (temple messengers or assistant priest and they represent the police) and (3) Temple committee.

Sthanikans are composed of 4 separate constitutional groups namely *Karnavanmar* (4 members) *Achanmar* (6 members), *Kodakaran* (1 member) and *Anthithiriyar* (2 members). *Karnavanmar* are the high priests of the temple and they act as magistrates belonging to 4 *illams* such as *chempillam*, *kachillam*, *karillam* and *ponnillam*. *Achanmar* are six in number and are basically oracles (*velichapadan*) at the temple and are assistant magistrates. *Kadavanmar* are the messengers/ police. Temple committee is a democratically elected body. The factors determining the legitimacy of *kadakkody* are divine authority, social embeddedness, systematic procedures and behavioural norms, participatory and transparent process, quick and fair judgements, functional diversity, shared sense of pride etc.

Typological differentiation of 2 forms of co-management: (Ramachandran, 2004)

Characteristics	Sui- generis form of CBCRM	State induced/supported CBCRM
Self Governance	High	Low
Basis of legitimacy	Divine	Legislative
Group of homogeneity	High	Medium
Compliance	High	Low
Social embeddedness	High	Low
Adaptability	High	Low
Ethos	Cosmic	Livelihood
Norms	Uncodified	Codified
Management agenda	Inclusive	Exclusive
Epistemological base	Socially embedded	Mostly officiated version
Ownership over means	Exclusive	Inclusive of production

Responsible Fishing Methods and Practices

- Guidelines associated with use and development of fishing gear and practices delineated in the Code focus on (i) selective fishing gear and practices (ii) environment friendly fishing gears (iii) energy conservation in harvesting and (iv) enhancement of resource (FAO 1995) The CCRF is purely voluntary. The best way to follow these codes will be adoption of co-management.
- Specific pointers from CCRF, in responsible fishing and practices, adaptable to Kerala include the following:
- Evolve regionalized consensus Code of Conduct for Responsible Fishing, in close participation with all stake holders (traditional, motorized and mechanised fishermen organizations) fisheries research organizations and fisheries managers
- Take measures to control open access by strict enforcement of a system of licenses (authorization to fish) in traditional motorized and mechanised sectors
- Develop ecosystem based fishery management regime, in collaboration with the union Government and neighboring maritime states sharing the same fishery-related marine eco system services
- Identify and delimit protected areas in marine and inland water ecosystems
- Periodically revalidate maximum sustainable yield of resources in the existing fishing grounds and determine fishing units in each category for sustainable harvesting of resources
- Take steps to remove excess capacity over a time schedule, with active stakeholder participation.
- Explore possibilities for a rights based regulated access system based on a strong inclusive cooperative movement of stakeholders with built-in transferable quota system and buy-back or rotational right of entry schemes for capacity management and optimization in the shelf fisheries, in collaboration with the Union Government and the neighboring states with confluent ecosystems and shared fishing grounds.
- Conduct periodic audit of fishing craft and gear combinations, their economics of operation and ecological impacts
- Standardize the capacities, dimensions and specifications of fishing units in each category, particularly in the mechanised and motorised sectors
- Evolve a system for marking fishing vessels and fishing gear (both traditional & mechanised)
- Maintain registry of all fishing vessels in waters under state jurisdiction with all essential details
- Evolve regulations and promote use of life saving, fire fighting and communication equipment for safety of fishermen
- Evolve regulations for mandatory survey of mechanised fishing vessels
- Promote selective fishing gear and practices
- optimum mesh size in trawl cod-ends
- Optimum hook size and shape for lines
- Square mesh windows in trawls
- By catch reduction devices in trawls
- Turtle excluder device in trawls
- Trawl designs with improved resource specificity

- Optimum mesh size for gill nets
- Optimum mesh size for purse seines
- Escape windows in fish and lobster traps
- Evolve an efficient Monitoring Control and Surveillance (MCS) system
- Promote effective use of Geographical Information System for fisheries management; monitoring and control of fishing effort and energy use
- Evolve an promote a package of practices for energy conservation in fish harvesting
- Evolve a mandatory programme of training and certification for non-motorized, motorized and mechanised fishermen in safe navigation responsible fishing, log keeping and reporting.

Perspectives and challenges ahead

Studies of various co-management implementations have revealed potentials and benefits of co-management, but also many unresolved issues and problems that need to be addressed. There is still a long way to go before a general understanding of various co-management systems and examples of solutions to all the major problems are available. A range of issues and problems need to be addressed: Developing co-management institutions on a larger scale than the local community: Many of the problems and issues facing. Fisheries can only be solved on a provincial, national or even international level. The resource systems on which fisheries rely are in most cases too large to be entirely within control of a few communities, and Fisheries management institutions must therefore be able to address problems of resource access and sharing on that level. The solution to this scale problem may be representation within nested systems, but this raises a new set of problems relating to mechanisms to ensure genuine representivity and to avoid a new process of alienation between communities and management is initiated. Reconciling local and global agendas: International agreements on fisheries and environmental management are a special case of incongruence between scales. Means must be developed by which the governments can serve the double obligation of attending to international agreements while sharing power in setting objectives for fisheries management with the communities. Identifying a knowledge base for management, which is considered valid by stakeholders: The knowledge base for fisheries management should relate to the objectives of management and be considered valid by the stakeholders? A co-management system must develop mechanisms to reconcile formal scientific knowledge and fishers' knowledge about their resource system in a way that maintains scientific validity and wide acceptance. There are no easy solutions to this problem. One approach may be to identify indicators of the status of the resource system that are both supported by science and reflects fishers' observations. Developing approaches to manage conflicts between resource users who have acquired exclusion rights to a resource through the co-management process and those who are excluded: There is a need to understand the mechanisms and actual reasons behind the alienation process of the different user groups in order to manage these conflicts. Developing appropriate approaches for empowering local communities to participate in the setting of management objectives through institutional reform: This may require substantial change in the way management authorities function to provide fisheries management services and changes in perceptions of stakeholders on the roles of fisheries management agencies. These issues must be addressed in practice—in practical experiments with co-management. It is however important that such experiments are documented and the experiences communicated to others who may be in the process of establishing or

developing co-management arrangements. It is therefore necessary that attempts to implement co-management are associated with independent research to document and disseminate the experiences.

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Management regulation for sustaining marine capture fisheries in Tamil Nadu¹

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Introductions

Fisheries have emerged as an important food production sector of the Tamil Nadu State contributing to the livelihood as well as food security of a large section of the people. Fishing activity, starting as a traditional livelihood activity in early fifties has now transformed into commercial enterprise contributing to the State and National economy, livelihood and nutritional security, rural employment generation and foreign exchange earnings significantly. It is one of the foremost States in India showing steady increase in fish production and optimum utilization of resources. Tamil Nadu has a coastline of 1,076 km on the east coast and 60 km on the west coast with a continental shelf area of 41,412 sq. km, and territorial waters of approximately 19,000 sq km. According to the 2010 Marine Fisheries Census for Tamil Nadu, covering its 13 coastal districts, there are 407 landing centres and 573 marine fishing villages in the State, with a total fishermen population of 0.82 million, of whom 0.214 million are active fishermen. The fishers belong mainly to the Paravar, Valaiyar, Kadaiyar and Karaiyar communities. In 2011-12, the total catch from marine capture fisheries in Tamil Nadu was 0.71 MT, of which 24.7 percent came from Ramanathapuram district followed by 19.8 per cent from Nagapattinam district, 13.5 per cent Kanyakumari and 11.6 per cent from Tuticorin district (CMFRI Annual Report, 2012-13). There are around 11,000 mechanized boats, 25,000 motorized boats and 10,500 non-mechanized boats in Tamil Nadu state.

Fishery resources need to be monitored and managed to maintain harvest at sustainable levels as they provide food and livelihood security to millions of population. Management of fisheries is not confined to management of stocks alone but it should consider all the stakeholders associated with the sector directly or indirectly such as fishers, traders, those involved in post-harvest operations and those who provide support services to the sector. (Vivekanandan *et al.*, 2010). Fisheries management tended to assume that the fishery and the target species existed in isolation from the rest of the ecosystem. As pressure

on resources and ecosystems increased, the shortcomings of single-species approach became more obvious. We now know that fishing not only impacts on the target stock, but on other parts of the ecosystem as well. For example, fishing methods are never selective and in addition to the target species, other species are inevitably caught. Some of the so called bycatch may be valuable and retained, while some bycatch may be discarded (Vivekanandan *et al.*, 2011). We have to formulate fishery management policy considering the domestic situations and promote sustainable fishing practices that will not decrease the stock level, but will ensure livelihood security, resource sustainability, economic efficiency and ecosystem integrity (Srinath and Pillai, 2008).

Current management measures

The **Wildlife (Protection) Act, 1972** provides legal protection to many endangered and threatened organisms viz., Marine mammals, turtles, some of the sharks, fishes like the giant grouper and sea horse, corals, sea cucumbers, gorgonids, some of the molluscs etc. There exists strict enforcement of rules against capture and possession of the protected animals. Joint patrolling is being carried out by the Forest Department, Fisheries Department, Police and Coast Guard to ensure better protection of endangered resources of Gulf of Mannar.

The **Marine Fisheries Regulations Act (MFRA)** was adopted in 1983, amended in 2000 and Rules notified in 1983. The regulatory measures formulated under the above Acts and Regulations by and large cover prohibition of exploitation of resources by destructive gears, explosives and poison, restriction of number of fishing boats, restriction of number of fishing gears which exploit juveniles in the backwaters, estuaries and shallow inshore waters, mesh size regulation, minimum legal length for capture, seasonal ban on fishing. The MFRA insists registration of all fishing vessels, and license required for fishing. Daily tokens are issued to mechanized vessels, to venture into the sea. The use of fishing gears with a mesh size of 10mm (knot to knot) is strictly prohibited. Pair trawling and purse seining are strictly prohibited. Bottom trawling operations within three nautical miles from the shore is restricted. Non-mechanised fishing vessel should operate within three nautical miles shall go for hook and line fishing and boat seine. Fishing within 100 metres below a river mouth is restricted. The owner of a non-mechanised fishing vessel shall not use his gill net in the channel earmarked as the passage for mechanised fishing vessel.

There is a trawl ban for a period of 45 days every year (closed season). Although seasonal fishing ban is just one of the many tools available for fisheries management, it is the only instrument which is being diligently followed in the country. Earlier there was no uniformity of ban period, but after the intervention of the Ministry of Agriculture, Government of India, the ban has been made uniform all along the west coast (June 15 – July 31) and east coast (April 15 – May 31) states and Union Territories. The closed season is followed during different seasons and for varying duration along the east and west coasts. Whereas closed fishing season appears to improve the catch for a few months after the ban is lifted, there is no indication on the sustainability of fish stocks and long-term benefits (Vivekanandan *et al.*, 2010).

Efficacy of existing management measures

It is well understood that management measure should be directed towards sustainability of natural resources. There is no doubt that a resource which is declining has to be restored by adopting all possible management measures, including total ban on harvesting of the resources, if necessary. However, it is also important that sound database is essential for considering a species or group to be included in the Schedule. It is felt that a realistic long-term database is not yet developed for the major resources. Such a database, if developed, will help in the long-term to evolve appropriate management measures.

Another vital aspect is to review the quality and availability of resources and ecosystem services after implementation of the management measures in order to compare it with the pre-management scenario. This should be given topmost priority and suitable agencies should be identified and the data should be collected to get a real picture. It is understood that in marine resource assessments, many assumptions are made to estimate the stock. However, the methodology adopted and the samplings methodology should be scientifically robust and well accepted.

There is also a lack of coordination and interaction in the implementation by different agencies. This is largely due to the multiple-ownership of the resources. Example - the conservation aspects fall under the jurisdiction of the Department of Forests, while the Department of Fisheries manages the fisheries resources. This dual control of the resource leads to many activities that are detrimental to the health of the ecosystem. Further, the current management measures in the region have not made any serious attempt on alternate livelihood options. Since the management measures are affecting the livelihoods of fishing communities, it would be appropriate to have a participatory conservation approach.

It is evident from the above that certain improvements are essential for the development of effective management measures. Sustainable exploitation of the resources can be practiced, with a participatory approach. It is seen that in some parts of the world, the coral reef ecosystem are permitted for sustainable exploitation, which can substantially contribute to the economy. The policy of total ban should be resorted only when it is absolutely warranted. Otherwise, the rules may be flouted with illegal exploitation of the resources, which is more harmful to the ecosystem.

Current issues in marine fisheries management:

- The fishing method is use of non-target groups and non-selective fishing gears. Hence species specific ban is irrelevant.
- From 1980-92 an increase in mechanised boats of nearly 50 percent has been reported in Tamil Nadu (Thirumiluet *al.*, 1994). This attracted investments from areas other than the fishermen community. The investment was initially in export trade and processing, but later direct investments in boats and hiring of fishermen as the crew and for maintenance transformed it into a modern, export-oriented industry (Hapke 2001).
- There is no limit on the number of trawlers. Hence, catch per unit effort (CPUE) is declining and per capita area per active fishermen is reduced.
- Trawling operation damages the gear and the crafts of the traditional fishermen.
- The conflict between mechanized and non-mechanized sector was mainly due to declining volume of catches faced by the traditional fishermen, intrusion of

mechanised vessels in the fishing grounds allotted for traditional fishermen, increased fishing pressure can be quoted as some of the reasons for the conflicts.

- The mean length of commercially important finfish and shrimp species in the landings is reducing, which shows that they are caught before breeding at least one time. Major reason for this is the use of nets, which have a small mesh at the cod end and thus end up catching juveniles. (presently the cod end mesh size used in trawl net is around 10 to 20mm whereas the specified size in the rule is 30 mm)
- Other reasons for this can be attributed to increased fishing pressure, damaging effects of bottom trawling, disposal of industrial wastes and thermal pollution, pollution by heavy metals, discharge of untreated sewage, over fishing and port related activities; coral and sand mining can also be quoted (Elin and Shaap 2003).
- Around 50 per cent of the by catch samples were immature fish that had no chance of spawning even once. (Salagrama, 2002).
- Trawling destroys habitats, shelter and suitable breeding areas for the fish and disturbing the larvae and eggs (Mounsey and Prado 1997, Vijayan, Edward and Ravindran 2000).
- Trawling method is indiscriminate as large amounts of noncommercially; juvenile, low value fish are also caught as by catch. The quantitative estimates regarding depletion levels are listed below: -Sivasubramaniam (1990) stated that 50 percent of the by catch samples he had studies were immature fish that had no chance of spawning even once. Salagrama (2002) and Sujatha (1996) found that by catch in Vishakapatnam by small trawlers amounted from 66-94 per cent of juveniles. The reasons being small mesh size at the cod end and the design of the cod ends (Vijayan, Ravindran and Edwin 2000)
- Horse power used in mechanized boat ranged from 200 & 500 hp. (According to act, the permitted range is 20 to 150 hp).
- Around 20 per cent of catch is discarded
- Use banned gears like purse seine, *roller madi* and pair trawling.



Mini trawls (Thalluvalai) causes serious damage to the sea grass beds. Non-target resources removed by the bottom-set gill nets



A view of roller madi nets used in Gulf of Mannar



Damage to bio-resources by trawl



Pair trawling

Proposed/expected actions for sustaining marine capture fisheries

- It is noted that many agencies are involved in the collection and collation of research data, evolving conservation measures and implementation of management policies. In addition, there are different stakeholders who are dependent on the resources and ecosystem services in the region. **A proper co-ordination and consultation between the different agencies involved is essential.** Presently, each agency is adopting a stand-alone approach and the data obtained is fragmentary and inadequate. Thus an **integrated approach** may be adopted. In this regard, the Government may constitute a committee incorporating all the agencies involved in the research and management of GoM and also include representatives of all the stakeholders who are dependent on the ecosystem services for their livelihood. The Committee should interact at regular intervals and make necessary recommendations to the Government for implementing the management measures.
- Providing **alternate livelihood** options is a matter of serious concern. Any awareness programme on the need of regulation of exploitation of resource is futile if alternate livelihood options cannot be provided to the fisherfolk who are dependent on the resources for their livelihood. In this context, small-scale mariculture practices can be encouraged as alternate livelihood options. Certain areas of the GoM can be demarcated as mariculture zones where **small-scale sea-cage farming, seaweed farming, lobster and crab fattening, oyster farming, ornamental fish culture and integrated farming of finfish and shellfish with seaweeds** can be promoted by Government agencies.
- Currently there are accepted methodologies for enhancement of stock of depleted resources. In this regard, conservation, mariculture involving seed production of the target species and **large-scale sea ranching** can play a significant role. The process is a non-commercial activity which has to be practiced on a massive scale involving R & D institutions and a host of voluntary agencies. Policies for providing incentives to

authorized voluntary agencies involved in such conservation and stock enhancement programmes will go a long way in the replenishment of many stocks.

- **Conservation of fisheries resources, protection of fish habitats and allocation to fishers are the three most important considerations in fisheries management.** In this process first the carrying capacity of the ecosystems and the biomass at each trophic level by taking into consideration the weather and hydrography of the ecosystem and fish biology has to be estimated. Based on the carrying capacity the number of crafts and gear required for sustainable harvest from the given ecosystem can be quantified. It helps to bring about a greater control over large-scale operations of non-selective fishing gear. If there is a need for reducing the number of crafts, Government can go for buy-back arrangement after negotiating with fishermen.
- **Fishing quotas** are worth considering as a system to restrict 'too many players' in the mechanised sector. To do so, careful estimation of the total available resource (X) and the Maximum Permissible Catch (MPC) or the Maximum Sustainable Yield (MSY) has to be done. The Department of Fisheries and other independent research bodies should be reviewed every year and they can facilitate in this mechanism. These fishing quotas would require us to clearly determine what percentage of the resource can be exploited by the traditional and mechanised sectors respectively. Here it becomes essential to create a market for fishing licenses for the operating trawlers. This license, in essence, is a right to over fish, or fish using techniques that might inflict a social cost to the traditional fishermen- a negative externality. So, determining the number of licenses that can be issued becomes a crucial factor.
- If all forms of fishing in certain area are banned altogether, the overall catch can be increased in a sustainable way. Since then, lot of studies have convincingly demonstrated that the creation of **no-fishing reserves** allows the rapid build-up of fish spawning stock biomass (Roberts and Polunin, 1991; Dugan and Davis, 1993; Allison et al., 1998). The idea behind reserves is simple. If the fish are protected from fishing, they live longer, grow larger and produce an exponentially increasing number of eggs. It is observed that adult fishes tend to remain in the protected areas while their larvae help replenish adjacent fisheries. Overall (multispecies) levels of biomass per unit area can double in two years and quadruple in ten years of closure. No-fishing reserves will work well for migratory species also if the reserves are put in the right places. Reserves placed in nursery and spawning areas will protect the migratory species during critical life stages. No-fishing reserves will work well for migratory species also if the reserves are put in the right places. Reserves placed in nursery and spawning areas will protect the migratory species during critical life stages. There are strong evidences to suggest that reserves will work even better in the tropics. However, there is no direct experience of reserves in India barring the marine sanctuaries in the fragile coastal zones to protect coral reefs and mangroves. Considering that the concept of no-fishing zone is a good strategic tool, fisheries managers should start working on the questions about how much of the fishing grounds should be placed in reserves, how many are needed, and where should they be.

- Government of India imposed a ban in 1982 on the export of material which is less than 75 mm in length. Since, all sizes of sea cucumber were indiscriminately collected without giving a chance for the animals to breed at least once during their life. But illegal trade of under-sized sea cucumbers continued. The Ministry of Environment & Forests brought all the species of sea cucumbers under Schedule I of the Wildlife Protection Act, 1972 and strictly banned their collection in 2001. The ban has affected the livelihood of a few thousand fishing populations. Many of them do not have an alternate livelihood avenue. A scientific in-depth study to understand and ascertain the present status of population of different species of sea cucumbers has to be done. Based on that if required species-specific can be implemented, instead of a blanket ban on all the species. Other regulatory measures which can be considered are implementation of “minimum legal size for capture”, effort control and monitoring, inclusion of “no take zones” within the Marine Protected Areas, “seasonal and short-term closures” of fishing, implementing “rotational harvest closures”, fixing of “catch quotas”, market chain licensing and reporting.

Conclusion

The current management measures in the region have not made any serious concern regarding the livelihood option. When a particular resource on which the livelihood of a group of fisherfolk are dependent, it is inhuman to put a total ban on the resource without regard to livelihood option. It is well known that for any management measure which is affecting the livelihood of a sector, it is better to have a participatory conservation approach. The current management scenario has not made enough scope for this vital aspect. The hard core conservation measures have to be reconsidered. The sustainable exploitation of resources from the area can be practiced whereas destructive practices have to be effectively curbed. On a global basis also, the coral reef ecosystems are permitted for sustainable exploitation. The policy of total ban should be resorted only when it is absolutely warranted based on the database created through careful scientific studies. Otherwise a lot of illegal exploitation of the resources is bound to happen, which is more disastrous and harmful to the ecosystem. The resource which is alarmingly declining has to be restored by adopting all the management measures including total ban. The vital issue is that realistic database should be available to consider a species or group to be included in the Schedule. The current management measures are adopted without a realistic and strong database regarding the status of the resources. Such types of management measures create lot of livelihood issues and hence will become redundant. Providing alternate livelihood options, fishing quotas, no-fishing reserves can be considered and implemented wherever it is feasible. Participatory approach to conservation where the different stakeholders voluntarily accept the regulatory measures is the best policy.

Dynamics of Self Help Groups in Indian Marine Fisheries Sector

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The concept of 'Self Help Group' (SHG) exists prior to any intervention. The SHG consists of members linked by a common bond like caste, sub-caste, community, place of origin, activity etc. in these 'natural groups' or 'affinity groups'. The 'Self Help Groups' provide the benefits of economies in certain areas of production process by undertaking common action programmes like cost effective credit delivery system, generating a forum for collective learning with rural people, promoting democratic culture, fostering an entrepreneurial culture, providing a firm base for dialogue and co-operation in programmes with other institutions, possessing credibility and power to ensure participation and helping to assess the individual member's management capacity (Fernandez, 1995). The open access regime existing in the harvesting of marine fishery resources in our country warrants stronger emphasis on invoking technological innovations as well as management paradigms that reconcile livelihood issues with concerns on resource conservation. Being the premier Marine Fisheries Research Institute in India with more than 6 decades of service to the nation, the Central Marine Fisheries Research Institute (CMFRI) suggests ways and means to sustain the potential source of food in capture and culture fisheries and their optimum utilisation. Innovations do not happen in a socio-political vacuum. It is the extent of partnership between the research and the client system that decides the fate of any technology in terms of its adoption or rejection. Rational utilization of common property resources for sustainable development without endangering the environment is possible through community participation.

Meaning of a micro enterprise

A micro enterprise is an activity which requires less capital, less manpower, local raw materials and local market. It is an individual enterprise whether known or unknown. (Vedachalam, 1998) In fisheries sector, for the upliftment of fisherfolk below the poverty line, some successful micro enterprises developed based on the location specific resource

availability and experience and some alternate avocations and subsidiary entrepreneurial ventures successfully being undertaken by Microfinance Institutions in coastal sectors and allied areas as follows: Value added fish producing units, Dry fish unit, Fish Processing unit, Ready to eat fish products, ready to cook fish products, Ornamental fish culture, Mussel culture, Edible oyster culture, Clam collection etc. are very important. In agricultural sector, Vegetable cultivation, Ornamental gardening, Floriculture, Kitchen Garden, Orchards, Fruit products, Fruit processing, Sericulture, Mushroom cultivation, Medicinal Plants, Vermi compost, Snacks units, Catering Units, Bakery Units, Cereal Pulverizing units are some micro enterprises undertaken by Self Help Groups.

Based on the resource availability and circumstances the micro enterprises those the SHGs' can generally bring to practical utility in allied sectors are Wood work units, Stone work units, Soap units, Garment units, Computer centre, Poultry centre, Cattle rearing, Piggery unit, Bee Units, Stitching units, Hand Weaving Units, Candles, Chalks, Umbrella units, Foam Bed Units, Bamboo based handicrafts, Paper cover, Scrape selling, Vegetable seeds, Marriage bureau, Medicine collection, Patients service, Real estate, Medicine processing, Direct marketing, Coir Brush, Plastic weaving, Second sails, Meat *masala*, *Rasam* powder, Curry powder, Pickle powder, *Sambar* powder, Consumer service centres, Home delivery package, Repacking business, Cleaning powder, Phenol lotion, Liquid soap, Washing soap, Toilet soap, Kids' garments, Toffee & Sweets, Photostat, Washing powder of best quality and medium type, Emery powder, Domestic animals, Nursery plants, Note book, Book binding, Rubber slipper production, Pillow cushion, Incense stick production, Cloth whiteners, Eucalyptus oil, Dolls, Hand shampoo, Soap shampoo, detergent shampoo, Jackfruit jam, Chips, Hotel, Catering service, Grape wine, Pineapple wine, Soft drinks, Chicken farming, Dried mango wafer, Dried chilli, Gooseberry wine, Ginger wine, *Pappads*, Tomato sauce, Day care centre, Coconut water vinegar, Syrups, Artificial vinegar, Mixed fruit jam, Milk chocolate, Tomato squash, Gum production, Cleaning lotion, Soft drink shop, Reading room, Private tuition, Counseling-guidance, Rent sales, Paying Guest service, Repairing centre and handicrafts are some of the employment opportunities that the SHGs' can venture throughout Kerala depending on the suitability of situations and availability of resources. The suitability of the enterprise varies from situation to situation. The essential features for the success of a viable micro enterprise are :

1. The availability of sufficient quantity of raw materials locally.
2. The identified enterprise is known or easy to learn and practice.
3. The cost of production must be low.
4. The products must be of very good quality.
5. The availability of market for the products.

The present study focuses on the relevance of mariculture successfully attempted by SHGs. Mariculture offers good scope for development in our open waters for enhancing food and livelihood security of the stakeholders in our coastal agro climatic zones. The micro enterprises suitable in fisheries sector for SHGs in this sector are Mussel culture, Edible oyster culture, Pearl culture, Seaweed culture, Cage culture etc. Mussel farming has already been proved as one of the profitable enterprises in the coastal belts as a subsidiary income-deriving source of coastal fisherfolk. The experimental trials conducted by CMFRI have proved the techno-economic feasibility of mussel farming. (Asokan *et al*, 2001,

Vipinkumar *et al*, 2001, Vipinkumar and Asokan, 2008). Here an attempt has been made on exploration of three case studies in Kasargod and Kollam districts of Kerala and Karwar of Karnataka on dynamics of Self Help Groups of fisherfolk engaged in Mussel Farming. Experiences and observations indicate that, for a group to be developed as a Self Help Group, normally a period of 36 months (3 years) will be required. Within this gestation period when the group passes through three distinct phases, up to 4 months as the Formation Phase, up to 15 months as Stabilisation Phase, and up to 36 months as the Self Helping Phase, the group gets led to the stage of a flourishing Self Help Group as per the indications given by social research results on Self Help Groups. The three distinct phases and the critical features are described as follows:

Group Initiation/Formation Phase (0 to 4 Months)

- The major steps in this phase should include the initial visit to the location, rapport building, awareness creation, identification of women fisherfolk, conduct of meetings, documentation of deliberations, action plans for arranging raw materials for the fishery based and diversified micro enterprises and the selection of 'leader of fisherwomen'

Building up / Stabilization Phase (4 to 15 Months)

- This phase must involve regular fortnightly meetings, maintenance of documents, scheduled implementation of action plan, procurement of inputs based on procurement plan as per production plan prepared based on market demand, market synchronized production planning, intensive training to carry out activities of production, credit and marketing aspects and changing the leaders of SHG after one year so that periodic rotation gives the other potential leaders a chance to lead.

Self Helping Phase (15 to 36 Months)

- The main steps to be included in this phase are the development of a fortnightly action programme, meetings for sharing experiences, refinement, and improvement and problem solving for the activities under the responsibilities of the leaders, The extension personnel's role will be limited to that of a facilitator, gradually reducing their presence at meetings. Active leaders will give way to new leaders after a two year term; inter-SHG contacts and healthy competition will be encouraged, favorable group atmosphere, empathy and interpersonal trust for significant achievements of SHG will be encouraged.

The fisheries Self Help Groups have to focus attention on joint efforts co-operatively for finding out suitable micro enterprises, which can assure a constant income for the fisherfolk, based on locally available resources for poverty eradication. The Group Dynamics of these SHGs refer to the interaction of forces between the members. It is the internal nature of the groups as to how they are formed, what their structures and processes are, how they function and affect the individual members and the organization. (Lewin *et al*.1960). In an intensive study of Group Dynamics, Pfeiffer and Jones (1972) identified the Group Dynamics factors as to how the group is organised, the manner in which the group is led, the amount of training in membership and leadership skills, the tasks given to the groups, its prior history of success or failure etc. In a detailed study of Group Dynamics, Hersey and Blanchard (1995) gave emphasis on helping and hindering roles individuals

play in groups such as establishing, aggressive, persuading, manipulative, committing, dependent, attending and avoidance. A couple of case studies on dynamics of Self Help Groups engaged in mussel culture are explored here.

1. Case study on Mussel Farming Self Help Groups of Women in Kasargod district:

The extreme north district of Kerala named as Kasargod, is particularly notable for mussel farming as it has been successfully accomplished by the women's Self Help Groups (SHGs) for the past few years. These groups were given financial assistance in the scheme namely; SGSY (Swarnajayanthi Gramaswa Rosgar Yojana) by the state government which takes care of economic empowerment of weaker sections (Vipinkumar *et al* 2001). Subsidies, bank loans etc are the part and parcel of it and it essentially focuses attention on poverty alleviation through organised Self Help Groups. This programme looks into training, credit, marketing, technical knowledge and basic facilities necessary for the upliftment of the poor to bring them above the poverty line within three years in such a way that they should have a monthly earnings of at least Rs 2000/-. It would be pertinent to have a look into the consequences of adoption and cost dynamics of mussel farming by the women's Self Help Groups in Kasargod district.

This district possesses an area of 1992 km² with a population of 10, 71508. The district with a population density of 538 km² has an average growth rate of 22.78 and 82.51 % literacy rate. Majority of the villagers earns their livelihood by agriculture, fishing, coir retting, coconut husk, toddy tapping etc. There is tremendous potential for aquaculture diversification in Kasargod coastal belts. Water bodies in these coastal belts have ample scope for the judicious utilisation of finfish culture, prawn and crab farming in Kasargod. (Asokan *et al* 2001).

This study was undertaken in two major panchayaths namely Cheruvathur and Padanna in Kasargod district. The study area, Cheruvathur panchayath has an area of 18.37 km² with a population of 24, 504 out of which 18, 631 people are literate. Agriculture is the main occupation of the majority and about 150 families are engaged in fishing as the main occupation and about 300 families as subsidiary occupation.

Similarly, Padanna panchayath has an area of 13.08 km² with a population of 17, 961 out of which 12, 746 people are literate. About 200 families are engaged in fishing as main occupation and about 400 families as part time occupation. The brackish water estuary systems of these panchayaths are extremely suitable for mussel culture. Six Self Help Groups of women (three each from both panchayaths) were selected as the sample and the data were gathered as explorative case studies through personal interviews of the respondents. For the study, the Group Dynamics of members of Self Help Groups was measured by developing an index called Group Dynamics Effectiveness Index (GDEI). Group Dynamics Effectiveness was operationally defined for the study as the sum-total of the forces among the member of SHG based on the sub-dimensions, such as participation, influence & styles of influence, decision making procedures, task functions, maintenance functions, group atmosphere, membership, feelings, norms, empathy, interpersonal trust and achievements of SHG. (Vipinkumar and Singh, 1998) For the computation of the Group Dynamics Effectiveness Index (GDEI), the scores obtained for each of the above mentioned sub-dimensions were first made uniform and then multiplied by the corresponding

weightage assigned to each as by expert judges. These scores were then added up to get the GDEI score of each respondent. It was also ensured that all the sub-dimensions identified as components of GDE were of high significance on the basis of the coefficient of agreement in judges rating as well as the statistical evidence from the results of the pilot study. The measurement device developed for the dependent variable *i.e.*, GDE was ascertained for its content validity.

Measurement of sub-dimensions

A. Participation: For the present study, participation was operationally defined as the degree to which the farmer is involved in group meetings, discussions and group activities of SHG.

B. Influence & style of influence: Influence was operationally defined as the degree to which a farmer can influence other member of SHG in a desirable way. Style of influence was operationalised as the manner in which the member attempts to influence other members of SHG. The four different styles included were autocratic style, peacemaker style, laissez-faire style and democratic style.

C. Decision making procedures: This is operationally defined as the degree to which farmer makes a decision with involvement of other group member of SHG, makes decisions without topic drifting, supports other members' decisions in consensus, feels the majority's decisions valid in the SHG, attempts to get all members participate in decisions of SHG and feels the gains of recognition for his contribution in decision making process.

D. Task functions: This is operationalised as the degree to which the farmer makes suggestions to tackle a problem in the SHG, summarises what has been covered in the group, tries to give or ask for facts, ideas, opinions, feelings, feed back etc. and keeps the group on target.

E. Maintenance functions: This is operationalised as the extent to which farmer helps others into group activities of SHG, helps/interrupts him in group discussions, feels the other members are co-operative and listening, perceives other members help in clarifying the ideas of all members, feels good or bad when ideas are accepted or rejected and the extent to which other members attempt to maintain task functions of SHG.

F. Group Atmosphere: This is operationalised as the extent to which the group member prefers friendly congenial atmosphere in the SHG, attempts to suppress conflict or unpleasant feelings in the group, feels other members are involved and interested and feels satisfied from the work climate.

G. Membership: This is operationally defined as the degree to which a group member feels accepted or included in the SHG, feels sub-grouping in the SHG and feels himself or other members to be outside the group.

H. Feelings: This is operationally defined as the degree to which the farmer feels anger/irritation, frustration, warmth, affection, excitement/boredom and competitiveness while performing the group activities of SHG.

I. Norms: This is operationalised as the extent to which the farmer feels the standards or ground rules and regulations are in operation that controls the behaviour of group members for the smooth functioning of the SHG.

J. Empathy: This is operationally defined as the degree to which the respondent is able to make out other person's feelings and thereby to understand it as he feels.

K. Interpersonal trust: This is operationally defined as the degree to which the respondent trusts the other members of the group as well as the faith other members have in him as perceived by the respondent.

L. Achievements of SHG: This is operationalised as the level of performance of SHG as perceived by the farmer as well as the performance of the farmer himself as the group member.

All these sub-dimensions were measured by a set of inventories containing appropriate questions arranged in a three-point continuum of always, sometimes and never with scoring pattern 2,1 and 0 for positive and vice versa for negative questions.

The cost estimates of all the selected Self help Groups were also computed and by taking in to consideration of major expenditure required for mussel farming is for the materials such as bamboo, nylon rope, coir, cloth, seed, etc. and labour costs essentially cover construction, seeding, harvesting etc. the Net Operating Profit and B:C ratio also were calculated for different SHGs to draw valid inferences. The basic data with regard to fisheries sector of Kasargod district is presented in Table 1. The study, focused attention on Group Dynamics Effectiveness as a trait of Self Help Groups resulted by the joint influence of individual members of the group generated out of skills and orientations from the past life experiences. It definitely varies from person to person, place to place, time to time, situation to situation and in turn from group to group. This might be the probable reason for the differential degree of GDEI observed among respondents.

Table 1 : General profile of fisheries sector in Kasargod district

Sl.No	Parameter	Kasargod
1	Length of the Coast line	70 km
2	No. of Marine Fishing villages	16
3	No. of Inland Fishing villages	2
4	Marine Fisher folk population 2004-2005	45989
5	Active marine fishermen	10566
6	Inland Fisher folk population 2004-2005	1004
7	Active inland fishermen	435
8	No. of Fisheries co-operatives	27
9	No. of domestic fish markets	164
10	Annual Marine Fish Production 2004-2005	8292 tonnes
11	Annual Inland Fish Production 2004-2005	1612 tonnes

Profile of Cost Estimates of Mussel Farming

The major expenditure required for mussel farming is for the materials such as bamboo, nylon rope, coir, cloth, seed, etc. and labour costs essentially cover construction, seeding, harvesting etc. The women's groups constituted in the scheme DWCRA started mussel farming as early as 1996-97 and are assisted by loan amount worth Rs 8800 / -per member with a subsidy amount worth Rs 4400/- which looks quiet fascinating. The duration of the loan is 5 years and the rate of interest is 12.5 % per annum. In addition to this, a revolving fund of Rs 5000 /- was also provided without interest. When the SHGs are economically empowered with the provision of loan facilities, the returns from mussel farming help them to repay the loan slowly. The loan was granted through Farmers' Service Cooperative Banks and North Malabar Gramin Banks in Cheruvathur and Padanna panchayaths of Kasargod district. Majority of the SHGs showed considerable progress in repayment of the loans, which can be concluded as an indication of the profitability of Mussel farming. The expenditure details of the selected SHGs in the initial year of mussel cultivation are shown in the Table 2. The Net Operating Profit in all the six SHGs was computed and found as substantially good which proves the profitability of Mussel farming in the initial trial itself and since during the subsequent years, material costs such as those of bamboo, rope, cloth and labour cost in construction etc. are negligible, this ensures reasonable profit as a major consequence of adoption of Mussel farming enterprise bringing about economic empowerment of rural women through organised Self Help Groups.

Table 2 : Cost estimates of the SHG's in mussel farming in Kasargod district.

	SHG1	SHG 2	SHG 3	SHG 4	SHG 5	SHG 6
No.of ropes	500	800	600	750	900	725
Items						
Bamboo	6400	9600	7980	9000	11437	7800
Nylon rope	9954	17500	12000	15000	18000	14500
Coir rope	1100	1500	1200	1587	2000	1450
Cloth	3000	3250	1700	3338	3600	2250
Seed	6500	10000	8700	9000	10800	9770
Labour						
Construction	1600	2400	2170	2250	2700	2200
Seeding	1500	2565	1500	1875	2500	1800
Harvesting	1300	2000	1500	2000	2750	1875
Miscellaneous	1000	1600	1200	1500	1800	1450
Total Cost	32,354	50,415	37,950	45,550	55,587	43,095
Returns	40,000	64,000	48,000	60,000	72,000	58,000

Net Operating Profit	7,646	13,585	10,050	14,450	16,413	14,905
B : C Ratio	1.236	1.269	1.265	1.317	1.295	1.346
GDE Index	52.78	54.33	53.91	57.32	55.68	59.14

Experiences and observations already indicated that for a group to be developed as an SHG, it requires a period of at least 36 months and it is a hectic process. It has to pass through various phases such as Formation phase, Stabilisation phase and Self Helping phase. These Self Help Groups promote a cooperative and participative culture among the members, which ensures the empowerment culture of the Self Helping phase. The loan sanctioning, utilisation, accounts maintenance and timely repayment of loans etc. are all perfectly accomplished with proper maintenance of the documented records by the group members. This ascertains the fulfillment of norms and standards of the SHG leading to economic empowerment of the members.

2. Case study on Mussel farming Self Help Groups in Karwar of Karnataka:

Self Help Groups (SHGs) of fisherfolk were mobilised in *Karwar* and *Bhatkal* locations of Karnataka coastal belts. Three SHG's of 15 members each comprising a total of 45 were mobilised in *Majali* (Open Sea) of *Dhandebag* and three SHGs of 15 members, each comprising a total of 45 were mobilised in *Sunkeri* of *Kali* estuary in *Karwar* coastal belts in *Uttar Kannada* district of *Karnataka* state. Training and demonstration on mussel farming was undertaken in these SHGs.'. Initially, two training and demonstration programmes in these two sites in *Karwar* were undertaken, one for *raft culture* in open sea in *Majali* of *Dandebag* and one for *rack culture* in *Sunkeri* of *Kali* estuary. The training was imparted to 45 members of three Self Help Groups, each possessing 15 members in 2 sites separately comprising a total of 90 participants. At *Majali* in open sea, a 5 x 5 metre raft and at *Sunkeri* of *Kali* estuary, a 5 x 5 metre rack were constructed for mussel farming.

Similarly In *Mundalli* river of *Bhatkal* estuary in *Karnataka*, 4 Self Help Groups of 15 members each exclusively of women fisherfolk mobilised under the NGO, 'Snehakunja' comprising a total of 60 participants were trained on mussel farming. They initiated a trial in 5 x 6 metre rack mussel culture by long line method. The sample design for observation including the number of SHGs' trained, beneficiaries and method of culture is given in Table 3.

Table 3: Mussel culture interventions in Karwar of Karnataka state

Site	No.Of SHGs Trained	No.of beneficiaries	Method of culture	Size of the rack / raft
Sunkeri of Kali estuary	3	45	Rack culture	5 x 5 m

Majali of Dhandebag	3	45	Raft culture	5 x 5 m
Bhatkal of Mundalli estuary	4	60	Raft culture	5 x 6 m

Essentially the data were gathered from these 10 Self Help Groups through personal interviews of the respondents. For the study, the Group Dynamics of members of Self Help Groups was again measured by developing an index called Group Dynamics Effectiveness Index (GDEI). The growth parameters were monitored every week in all the sites and the yield particulars of mussel during harvesting in each SHG was also noted. The major expenditure required for mussel farming is for the materials such as bamboo, nylon rope, coir, cloth, seed, etc. and labour costs essentially for construction, seeding, harvesting etc. The SHGs of *Majali* and *Sunkeri* were mobilized by the project team of CMFRI and the SHGs of *Bhatkal* were mobilized by a NGO namely *Snehakunja*. The first two trials and demonstrations were under the funding of CMFRI and for the last one, only the technical helps during the training and demonstration were offered by CMFRI. The yield particulars in all the ten SHGs were noted and found as substantially good which proves the profitability of mussel farming in the subsequent trials because the material costs such as those of bamboo, rope, cloth and labour cost in construction etc. are negligible, this ensures reasonable profit as a major consequence of adoption of Mussel farming enterprise bringing about economic empowerment of rural women through organised Self Help Groups.

The open sea mussel culture in this particular case met with the impediment of unfortunate sabotage of the seeded mussel by some miscreants. It was rectified by reseeded, but the yield was not that much conspicuous compared to the trials undertaken in estuaries. The yield in Kg per metre length of the rope recorded in all SHGs as Average Yield showed a positive relationship with GDEI score (Vipinkumar.V.P, 2005). The correlation ($r = 0.958139$) was found significant owing to the 't' value 9.465624 at 1% level of significance. (Table 4) Experiences already indicated that for a group to be developed as an SHG, a period of at least 3years will be required. It has to pass through three distinct phases such as Formation phase, Stabilisation phase and Self Helping phase. These Self Help Groups promote a cooperative and participative culture among the members, which ensures the empowerment culture of the Self Helping phase. The utilization of fund sources, accounts maintenance etc. are all systematically accomplished with proper maintenance of the documented records by the group members. This ascertains the fulfillment of norms and standards of the SHG leading to economic empowerment of the members.

Table 4 : Relationship of Yield and GDEI of selected SHGs in Karwar

SHG	Yield in Kg/ m	GDEI score	Correlation Coefficient (r)	't' value
SHG 1	9.2	53.71	0.958139	9.4656248
SHG 2	9.1	52.31		
SHG 3	8.9	51.91		

SHG 4	12.6	57.32		
SHG 5	12.7	56.68		
SHG 6	12.5	57.14		
SHG 7	13.6	60.01		
SHG 8	13.1	59.98		
SHG 9	13.8	61.29		
SHG 10	13.2	60.02		

3. Case study on assessment of mussel farming technologies in gender perspective in Kollam district of Kerala

An attempt was made on assessing the mariculture technologies in gender perspective in mussel farming in Kollam area of Southern Kerala as a subsidiary income-deriving source of rural fisherfolk. The experimental trials conducted by CMFRI have proved the techno-economic feasibility of brown mussel farming in Kollam area. Kollam district of Southern Kerala is conspicuous for the brown mussel farming through the women's Self Help Groups organized through *Kudumbasree ayalkoottams*. It would be pertinent to have a look into the consequences of adoption and cost dynamics of mussel farming by the women's Self Help Groups in Kollam.

Geographical aspects of Kollam district

Quilon or Kollam, is an old seaport town on the Arabian coast. About thirty per cent of this district is covered by the Ashtamudi lake, thereby making it the gateway to the backwaters of the state. Kollam District which is a veritable Kerala in miniature is gifted with unique representative features - sea, lakes, plains, mountains, rivers, streams, backwaters, forest, vast green fields and tropical crop of every variety both food crop and cash crop. Area : 2,491 km² with a population : 25,84,118 and the Literacy level of 91.49 %. The district has a prominent place in the field of agriculture. The total extent of land under cultivation is **2,18,267** hectares. The principal crops are **paddy, tapioca, coconut, rubber, pepper, banana, mango and cashew**. About 70 per cent of the work force is engaged in agriculture. Coconut gardens extend to about 75,454 hectares. The five major crops: paddy, tapioca, coconut, rubber, pepper - are cultivated in an area of 1,73,847 hectares. Small and marginal farmers constitute more than 95% of the farming community and the average per family holding is 0.21 hectare. The basic data with regard to the fisheries sector of Kollam are presented in Table 5.

Table 5 : General profile of fisheries sector in Kollam district

Sl.No	Parameter	Kollam
1	Length of the Coast line	37 km
2	No. of Marine Fishing villages	27
3	No. of Inland Fishing villages	26
4	Marine Fisherfolk population 2004-2005	96703
5	Active marine fishermen	21368
6	Inland Fisherfolk population 2004-2005	36653
7	Active inland fishermen	6255
8	No. of Fisheries co-operatives	99
9	No. of domestic fish markets	324
10	Annual Marine Fish Production 2004-2005	143138 tonnes
11	Annual Inland Fish Production 2004-2005	10778 tonnes

Kollam is an important maritime district of the state with a coast line of 37.3 kms. Fishing has a prominent place in the economy of the district. Neendakara and Sakthikulangara villages thrive in fishing. An estimated number of 22,000 persons are engaged in fishing and allied activities. Cheriazheekkal, Alappad, Pandarathuruthu, Puthenthura, Neendakara, Thangasseri, Eravipuram, Paravoor and Thekkumbhagam are nine among the 26 important fishing villages. There are 24 inland fishing villages also. Considering the unique location and infrastructure available, the Government has initiated steps for establishing a fishing harbour at Neendakara which is expected to augment fish production by 15%. Average fish landing is estimated to be 85,275 tonnes per year. One third of the state's fish catch is from Kollam. There are 93 producer co-operatives, two credit cooperatives and one marketing cooperative in the fisheries sector. There are 38 Fishermen Development Welfare Cooperative Societies in the district. Nearly 3000 mechanised boats are operating from the fishing harbour. FFDA and VFFDA are promoting fresh water fish culture and prawn farming respectively.

The present study was undertaken in Kaunagappally thaluk <http://kollam.nic.in/karumap.html> situated 27 Kms north to Kollam. It is linked with Kollam by rail and road. Thekkumbhagam and Needakara panchayats were selected from this thaluk. Of these, Dhalavapuram and Malibagam villages of Thekkumbhagam panchayat and Pannakkal thuruthu and Puthan thuruthu villages of Neendakara panchayaths were selected for data collection. Data were collected from 200 mussel farming households mobilized in Self Help Groups in these villages to represent the Southern part of Kerala

through the trained enumerators. The man and woman of each family were separately interviewed to get the response to assess the gender need and gender role with the help of a pre tested well structured interview schedule to get the response to assess the gender need and gender role. In addition to this, 4 Self Help Groups of women from each panchayath were selected to draw explorative case studies through personal interviews of the respondents. In addition to this 4 Self Help Groups of women from each panchayath were selected to draw explorative case studies through personal interviews of the respondents (Table 6). The Benefit -Cost ratio was analysed in each group and cost dynamics were worked out. The problems and constraints faced by the women were also assessed in each case and listed out.

Table 6. Details of the basic information gathered & SHGs identified in Kollam district.

Name of the panchayat	Village	Samples selected (Self Help Groups)	No. of members
1. Thekkumbhagam	Dhalavapuram	Mahatmaji Kudumbasree Group	19 members
	Malibhagam	St.Maries Kudumbasree Group	16 members
2. Neendakara	Puthan thuruthu	Ashtajalarani Group	18 members
	Pannakkal thuruthu	Chavara south Group	15 members

Gender Role and Gender Need in Mussel Farming

In Kollam district, the gender participation in different activities, gender needs, decision making and access and control over the resources in respect to mussel culture were analyzed. Opinion of men and women in above aspect was found to be similar without any significant difference. However, differential gender response was observed between the villages. Significantly, the accounting/money transaction is under the control of women and the most important requirement perceived by both men and women is the timely availability of spat. In case of participation and need, both men and women share almost the same opinion. (Sahoo *et al*, 2009) Socio-economic, technological and export support requirement was analyzed for gender mainstreaming.

Profile of Yield aspects & Groups Dynamics of Mussel Farming in Kollam

The major expenditure required for mussel farming is for the materials such as bamboo, nylon rope, coir, cloth, seed; etc. and labour costs essentially cover construction,

seeding, harvesting etc. The relationship of yield and GDEI of selected SHGs is presented in Table 7. The yield in Kg per metre length of the rope recorded in all SHGs as Average Yield showed a positive relationship with GDEI score. The correlation coefficient value was ($r = 0.92025$)

Table 7. Relationship of Yield and GDEI of selected SHGs in Kollam district.

SHG	Yield in Kg/ m	GDEI score	Correlation Coefficient (r)
SHG 1	14.6	60.08	0.92025
SHG 2	12.1	57.78	
SHG 3	13.9	59.16	
SHG 4	15.1	62.17	

Observations in case studies undertaken in Kollam on brown mussel farming Self Help Groups of women also indicated that for a group to be developed as a fully potential SHG, it requires a period of at least 36 months. After 3rd year, most of the groups in the study areas are in the Self Helping phase. Most of these groups promote a cooperative, participative and empowerment culture among the members. The loan sanctioning, utilisation, accounts maintenance and timely repayment of loans etc. are also accomplished judiciously and systematically with proper maintenance of the records by the group members. This ascertains the economic empowerment of the members through organised Self Help Groups.

Problems and constraints of gender in mussel farming

Mussel farming faces a number of impediments like water salinity, seed availability, selection of location/site, climatic vagaries, identification of proper beneficiaries and proper monitoring opportunities. The major problems and constraints faced by the women in mussel cultivation in the rank order are Unpredictable seed availability, Meat shucking problem, Marketing of mussel, Mortality of seeds during transportation, Reduced growth during certain years, Social constraints like caste splits, conflicts etc. to a limited extent. Here also, all the group members are of unanimous opinion that the government agencies should come forward with improved marketing facilities as marketing of the mussel was perceived as one of the biggest constraints. Provision of loans with reduced interest rates and freezer facility for storage of harvested mussels can bring about a breakthrough in this sector in the near future.

The consequence of adoption of mussel farming when accomplished through organised Co-operative Groups of women in North Malabar areas and South Quilon areas of Kerala state is achieving considerable significance because of its tremendous profitability. It is quite interesting to proclaim in the near future that mussel culture is being fully grown up to possess the potential to be known as an exclusive women based independent enterprise in Kerala. It would be vital to look up on the gender issues in the selection of suitable sites and various operations fulfilling the essential parameters for undertaking mussel culture trials.

An assessment of gender role and gender need is inevitable in this context. It would be pertinent to have a study on the drudgery in mussel farming trials as well as effect of coir retting zones on growth and attachment of mussel seeds to the strings, which often found by experiences and observations. Laboratory experiments should be broadened to study the effect of coir retting zones on growth of mussel. Similarly, export potential of mussel can be promoted through value addition experiments on depuration plants in filtered seawater. Organised fishermen's cooperatives can play a vital role in various stages of seeding, harvesting, sorting, grading, packing and marketing with an intention of export potential. Irrespective of the location specific problem oriented resource based alternative programmes for income generation, this study emphasises on the gender need and gender role also ultimately for economic empowerment through mussel farming as a means of poverty eradication through Self Help Groups.

Open sea cage farming

Open sea cage farming is a promising venture which offers the fishers a chance for cultivating marine fishes and for optimally utilizing the existing water resources. As and R&D activity, CMFRI launched the first open sea cage 15 m diameter made High Density Poly Ethylene (HDPE) in the bay of Bengal off Visakhapatnam coast during May 2007. The second and third versions of marine cage were all found sea worthy at any extreme sea conditions. For easy management and cost effectiveness in terms of reduced labour, the size of the HDPE cages has been modified to 6 m in the 4th version. In a series of demonstration trials, these cages have been found to be successful in many maritime states along the Indian coasts. Latest version of pen sea cage is a cost effective GI cage designed for low investment farming operations found to be suitable in west coasts. Cage culture is a low impact farming practice with high economic returns. The system is eco-friendly without any human intervention, and a higher survival of above 75% was achieved and sustained. The candidate fish species grown in cages are sea bass, red snapper, chanos, mullets, cobia, pompano, groupers, koth, pomfrets, lobsters etc. The mariculture in open sea cage devised under the present invention will expand a new mariculture space, thereby the mariculture scale can be expanded greatly; simultaneously the self-pollution of mariculture can be solved. Now a low cost cage made of GI pipes were also being used in silent bays of east coasts. Self Help Groups initiated by CMFRI undertook cage farming for edible oyster in Moothakunnam areas.

Seaweed Culture

Around 60 species of commercially important seaweeds with a standing crop of 1,00,000 tons occur along the Indian coast from which, nearly 880 tonnes dry agarophytes and 3,600 tons dry alginophytes are exploited annually from the wild. Seaweed products like agar, algin, carragenan and liquid fertilizer are in demand in global markets and some economically viable seaweed cultivation technologies have been developed in India by CMFRI and Central Salt and Marine Chemical Research Institute (CSMCRI). CMFRI has developed technology to culture seaweeds by either vegetative propagation using fragments of seaweeds collected from natural beds or spores (tetraspores/ carpospores). It has the potential to develop in large productive coastal belts and also in onshore culture tanks, ponds and raceways. Recently the culture of the carageenan yielding sea weed

Kappaphycus alvarezii has become very popular and is being cultivated extensively along the Mandapam coast. To make the seaweed industry more economically viable, research aimed at improvement of strains of commercially important species by isolating viable protoplasts and somatic hybridization techniques is being carried out. The rate of production of *Gelidiella cerosa* from culture amounts to 5 tonnes dry weight per hectare, while *Gracilaria edulis* and *Hypnea* production is about 15 tonnes dry weight per hectare. Pilot scale field cultivation of *Kappaphycus alvarezii* carried out in the near shore area of Palk Bay and Gulf of Mannar showed maximum increase in yield of 4.3 fold after 30-32 days in Palk Bay and 5.7 fold after 22-34 days in Gulf of Mannar. This is a promising venture being undertaken by the women's Self Help Groups in Mandapam. So far as much as 1200 families were engaged in seaweed farming of which 60% of the farmers are women.

Conclusion

An attempt has been made to assess the socio economic impact of mussel farming by mobilizing Self Help Groups in Kasargod and Kollam areas of Kerala and Karwar area of Karnataka coastal belts. Mussel farming is achieving considerable significance because of its profitability. But it is inevitable to take care of the selection of suitable sites fulfilling the essential parameters for undertaking mussel culture trials. It would be pertinent to have study on the effect of coir retting zones on growth and attachment of mussel seeds to the strings, which often found to be not suitable by experiences and observations. Laboratory experiments should be widened to study the effect of coir retting zones on growth of mussel. The consequence of adoption of mussel farming when accomplished through organised Self Help Groups of women in North Malabar areas and South Quilon areas of Kerala state is achieving considerable significance because of its tremendous profitability. Export potential of mussel can be promoted through value addition experiments on depuration plants in filtered seawater. Organised fishermen's cooperatives can play a vital in various stages of seeding, harvesting, sorting, grading, packing and marketing with an intention of export potential. As mussel seed availability is a major constraint, efforts should be initiated for widening the mussel seed production technologies developed by CMFRI on a larger scale. The study emphatically disclosed the deep rooted influence of Group Dynamics network among the farmer folk as influenced by their participation, influence & styles of influence, decision making procedures, task function, maintenance function, group atmosphere, membership, feelings, norms, empathy, interpersonal trust and achievements of SHG. Irrespective of the location specific problem oriented resource based alternative programmes for income generation, this study emphasises on the economic empowerment of rural women through mussel farming as a means of poverty eradication through Self Help Groups because, poverty can only be alleviated by mobilising the poor to solve their actual problems in the form of organised SHGs'. In the impact assessment, the correlation analysis revealed, a proportional relationship between the Group Dynamics Effectiveness and Average Yield obtained for each SHG, which ensures reasonable profit as a major consequence of adoption of Mussel farming enterprise bringing about economic empowerment of fisherfolk through organised Self Help Groups.

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Gender issues in Harvest and Post harvest sectors of Fisheries- Understanding fisheries from a gender perspective

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'Women hold up half the sky'.

This is a proclamation made by Mao Zedong. This holds exactly true for India, as women amount to about half the country's total population. So, there could be no emancipation for humanity without the participation and emancipation of half of society – its women.

Now coming to fisheries sector, 14 million people depend on fisheries for livelihood through different occupations. Out of its one billion population, 20 % are living in the coastal villages. India, having 3rd position in marine fisheries production and 2nd in Aquaculture is having a prominent position in the world fisheries map. 14 million people depend on fisheries for livelihood through different occupations. The contribution of fisheries to the GDP is around 1.4 % and about 5% to the Agriculture GDP.

Coming to these coastal villages of India, which make Fisheries the sunrise sector of our economy, the women's role is still higher. Though fisheries sector has long been considered as a male domain indicating the higher degree of risk and the ergonomic issues involved in the occupation, the fact is position of women is higher by statistics compared to men in most of the fishery activities. This can be easily understood if one can have a glance of the various labour intensive fishery activities like gleaning, processing, curing and marketing. And the role of fisheries is steadily increasing through food supply, generating job opportunities, raising nutritional level and foreign exchange earning. But these days, there arises a lot of discussion about the need for gendered approach in fisheries..Why?

What is gender?

Gender is the state of being male or female. The word gender has been used since the 14th century as a grammatical term. The term is believed to be originated from, old French *gendre* based on Latin *genus*. The earliest meanings were kind, sort genus etc. But the word gender became popular by middle of 20th century.

What is the difference between sex and gender?

Sex refers to the biological differences, while gender refers to cultural or social ones. Gender and gender based differences expressed in personal or social contexts can never be attributed to only the biological differences, it is a cumulative effect of the cultural, social as well as psychological differences established through ages.

The role of women in fisheries sector- in a gender perspective

Data from nine significant fish producing countries, based on available national statistics and case studies, revealed that 47% of the labor force in the fisheries sector (including post-harvesting) is women (FAO, World Bank and WorldFish, 2008). If those in gleaning and aquaculture were also accounted, these figures could have been still higher. Employment in this sector is expanding.

As women form the majority engaged in post-harvesting in many countries(with very few exceptions where women are involving in harvesting occupations), revised estimates of employment in fisheries could indicate that the sector is predominantly a female one, challenging the long-held notion that fisheries is a male domain.

In India, fish is mostly regarded as only a secondary source of food. Under such circumstances, fishing communities receive a lower priority in state policies relating to food. The picture becomes shabbier when it comes to the women of this marginalized group. Their role in the fisheries sector remain invisible, with their contribution by way of manpower going unrecorded for the documentation of work participation in fisheries. Before going to the issues confronting women in fisheries, it would be better to have a quick look at the role they play in the sector;

Harvest sector

The presence of women in harvesting operations in the marine sector is very low. In some states like Tamilnadu and Andrapradesh, women help to pull the traditional crafts to shore, in which mostly their husbands or the close relatives might have brought fish from sea. Later they take over the responsibility of marketing the fish. In many areas including Kerala, women go for fry collection in traditional way using pots. When Pokkali (half the year fish & half the year paddy) lands of Kerala are declining, the scene of women catching fry is also declining. In Andrapradesh, the women mainly involve in gathering fish while landing and collect molluscan shells. They also involve in clam & mussel collection from brackish water areas. The marine operations extend from few weeks to a month or more and distance of operation also expands. While the harvesting operations in marine sector become more and more technologically advanced, women's scope of venturing into it becomes limited. Also, women are actively involved in sea weed collection and crab farming in Tamilnadu coast. Women indirectly contribute to the marine harvest process by mending

net, selling harvesting equipments etc. Also, in states like Maharashtra , fisherwomen are custodians of fishing boats and they give boats on lease to fisherfolk for fishing.

The role of women in Inland fish harvesting is more prominent. They are engaged in pond preparation, stocking of fingerlings, feeding harvesting etc in aquaculture ponds. In open water bodies, they do fishing from shore in some places. In the North-eastern states like Manipur, women go to deeper lakes in boats of unique design and catch fish in an interesting traditional method using an indigenous gear resembling the Chinese dip net of Kerala. During the voyage extending to 4-5 hours, they do sometimes have their children also in the boat.

Post-harvest Sector

The contribution of women is significantly high in post-harvest operations in fisheries. The entire processing sector is dependent on women as all most 90% of the prawn peeling and 70% of the processing of fish is performed by women. They also play a major role in fish(both fresh & dry) trading, curing, value addition and sorting work in major landing centres.

If we take the case of Kerala state alone as a case, out of the total working women force in fisheries, 45% are employed in prawn peeling centres, 24 % in small scale fish trading, 16 % in processing centres and the rest in small alanding centres, fish curing etc. In Kerala women are involved in fish curing, pre- processing, and marketing. In Tamil nadu, other than these roles, presence of women is there in sea weed collection and value addition also. In west Bengal, Orissa and Maharashtra, the presence of women in fish processing & marketing is very predominant.

Other than these major direct roles, women play many indirect roles like taking additional responsibility of looking after all the needs including financial of the family in the household of a fisherman employed in mechanized fishing sector during his absence for weeks together. Also they run petty shops in landing centres, selling ancillary equipments for fishing, food stalls for fishing crews etc.

Though the potential of the coastal women folk for contributing to the development of fisheries is very high, slowly their opportunities are declining. This can be attributed to a great extent to the technological advancement s took place in the sector without keeping a gender balance.

Gender in fisheries- the major issues

Its employment that is of grave concern for us when we speak of gender issues in fisheries, while all other issues are rooted in the general social and cultural background. A livelihoods approach (Long, 2000; Allison and Horemans, 2005) better enables an understanding of how employment in the fisheries/aquaculture sector is embedded in other social, cultural, economic, political and ecological structures/ processes that shape gender inequities and how these might be reduced.

But due to the advent of mechanization in fishing sector, the fishing activity became industrial in nature. Highly advanced mechanized fishing boats, operating from major fishing harbours made fishing occupation a centralized nature. Though almost 70% of the

fish landed is going for domestic consumption, the fishing operations became export oriented. It has opened up some new employment opportunities for women in centralized peeling & processing centre soft exporting firms. But the women had to travel from their residences to faraway places (often to other states) & the job became seasonal, creating a feel of insecurity. This displaced women who were employed in the numerous small traditional landing centres. Usage of fishing nets made of improved synthetic materials made in big factories made women in net making jobless. The technological changes brought in to meet the increased demands for production & processed products didn't equip women

Gender issues- Beyond Gender differentiation

Gender bias in division of labour- this is one of the major topic which is widely debated all over the world. The differentiation based on gender starts in the beginning itself..the jobs in fisheries has an invisible categorization as some for men only & women can do only some, which naturally fall into the inferior jobs and low paid. Even if few women also get into the same jobs as men, the next issue will come up;

Gender disparity in wages

The women who do same job of men in the same firm are not paid equal to the men. This is very prevalent in Agriculture sector. The ones who are responsible for the implementing the wage disparity has always got the justification of poor productivity of women. Here, the value of skill acquisition and time (for eg; women from Alleppey district of Kerala who are well known as the best in the skill in India is paid low wages irrespective of the states they work).

So, the story of discrimination goes on it was being discussed from many years back. The gender based marginalization of women in fisheries sector is a topic of hot discussions in different national and international platforms which has paved way for many studies on her work participation in fisheries and the policy support they receive. This has led to a plethora of studies and loud discussions.

Providentially, we are on the right track as the development or in more specific terms, the empowerment, of the women can be made tangible mainly through assessing their economic empowerment ie., through rates of women getting employed in the sector. Because, economic empowerment is the foremost of all other kinds of empowerment like social, cultural and intellectual as it enable her to have an access to information and resources for growth in other sectors.

Apart from these, the generally reported constraints include, **lack of access to information sources, lack of ownership of assets, no decision making power, no managerial efficiency, improper policy support, research programmes focusing and technological empowerment of women**

Beyond gender bias in division of labour & wages...

But often, the focus of these discussions is limited to two main aspects; ie., gender bias in division of labour and wage disparity. But we have to move beyond this limit considering the globalization, market changes and growth of research in fisheries. What is needed is a redefining of the outlook for gender based development in fisheries, keeping an eye on the

changing consumption pattern, emerging market forces and technological developments fisheries sector.

The plans to be made for bringing in a sustainable development in the sector should surely include well define programmes for equipping the neglected, but productive half of the society. But the approached need to be women oriented considering the macro climate in fisheries. The development agenda in fisheries is set considering the future market demand and sustainability concerns. Keeping these in focus, we have to leap forward devising new programmes to bring the women folk in coastal villages forward. There has to be focused attempts considering the on the following lines;

Future perspective:

Gender friendly technology packages

Gender friendly technology packages are to be devised for equipping women to get employed in the changed regime of fisheries. For example, the creative & innovative potential of women in making food products is not yet tapped fully.

- A proper technology support will enable them to make sure that they play a key role in the snack food processing industry, which is promised to be the sunrise sector of India. Preparation of ready to eat and ready to fry products for urban market is another area where coastal women can excel. The products have growing demand in domestic as well as foreign markets. (The techno-preneurship models developed for value added products, dry fish, fresh fish, fish waste utilization, Bombay duck production etc under the NAIP project “Responsible harvesting and Utilization of Selected small pelagic & fresh water fishes” operated in CIFT with World bank support are examples of few such viable business models for women).
- Women can be supported for starting production units as well as run selling kiosks of these innovative products
- Women can be also equipped to acquire skills for production and servicing of modern fishing equipments.
- Advanced training for scientific aquaculture practices for farming commercially important and fast growing fishes, crab fattening and farming of bivalves ia another promising area

Policy support

In a democratic country like India, a political will can do wonders for bringing in improvement in a sector through focused ventures. Supportive schemes and policy decisions are to be made which customized to meet the demands of the sector

Financial

Most credit institutions have not been able to recognize them well enough to cater to their specific needs. Under such circumstances, the credit needs of women for fish marketing often get ignored. This keeps them dependent on exploitative non-institutional credit sources, which eventually prevent them from making a decent living. Remedial measures are to be urgently undertaken to solve this issue.

Managerial efficiency

This is a point of utmost importance as the reason for collapse of 90% of the failed initiatives by women entrepreneurs or women groups is attributed to improper management. Hence proper guidance & professional training is highly essential for enabling women in providing managerial inputs for their enterprises.

Research initiatives

Research initiatives are highly essential for two purposes; i) for proper indepth study for documenting statistically of the status of women in various spheres of fisheries)& multi-dimensional issues, which is still lacking. It should bring out meso- and micro-level analytical studies on how employment in the fisheries/aquaculture sector is gendered and embedded in wider social, cultural, economic, political and ecological structures and processes

ii) To develop women oriented technologies as well as techno-preneurship models to equip women economically.

Though other issues like **social discrimination, lack of access to Asset and lack of decision making power** are prevailing in the field, they can be addressed only through concentrated efforts by different agencies as the change is to happen in the social system. As the problems due to belief systems and customs restricting women cannot be addressed through fisheries related development initiatives, we need to focus on the technological , financial as well as policy support to enable women for achieving an economic empowerment, which will help them to overcome the other bottle necks through a gradual process.

Gender equality is more than a goal in itself. It is a precondition for meeting the challenge of reducing poverty, promoting sustainable development and building good governance ...KofiAnnan

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Relevance of Indigenous Technical Knowledge for Responsible Fisheries

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Introduction:

The code of Responsible fisheries was adopted in 1995 by the members of the food and Agriculture organization of the United Nations.

The code is a voluntary instrument that addresses many aspects of fisheries. Its scope includes marine and fresh water fisheries, wild and farmed resources, and harvesting and post-harvest operations.

The code encourages the national and sustainable utilization of fishery resources, in capture, processing, trade in fish and fishery products fishing operations and aquaculture.

Ultimately the code aims to promote the contribution of fisheries to food security and quality, satisfying the nutritional needs of local communities.

Relevance of the code to indigenous people.

The code refers to 'indigenous peoples' in only one article (i.e Article 7.6.6). It does not specifically mention the term indigenous peoples but rather uses the generic term "small-scale and artisanal fisheries". In this context, indigenous fishing communities are considered as a component of the small-scale and artisanal fisheries category.

Definition of indigenous peoples:

Indigenous people are characterized by the following features:

- a) They are the people who usually maintain a strong attachment to particular geographical locations and ancestral territorial origins.
- b) They remain culturally, geographically and institutionally distinct.

- c) They preserve elements of their own socio-cultural economic and political ways of living and knowing.
- d) They overtly self-identity as “indigenous” or tribal.

The indigenous fishing communities are involved in activities that are:

- a) Targeted on supplying fish and fishery products for local markets and for subsistence consumption.
- b) They are involved in ancillary activities such as net making and boat building.
- c) They provide fishery related employment and income opportunities in marine and inland fishing communities.

The international labor organization (ILO) convention No. 169 envisages the rights of ownership and possession over lands they traditionally occupy, rights to natural resources, right to participate in the use, management and the right to decide their own priorities for development and to exercise control over their own economic, social and cultural development.

The UN declaration adopted by the general assembly in September 2007 affirms the indigenous peoples right to participate fully in the political, economic, social and cultural life of the state and to be consulted in decision affecting them for obtaining their prior, free informed consent.

Provisions of the code that are relevant to indigenous fishing communities:

1. The codes objective of achieving conservation and sustainable use of fishery resources resonates with the values of indigenous peoples.
2. In indigenous communities, the concept of sustainability is entrenched in customary values.
3. Indigenous people have extensive knowledge in managing fishery resource and are important partners for local, national governments as well as for international organizations.
4. Indigenous people protect biodiversity and their role in protecting biodiversity and sustainable management of aquatic resources, respecting their customary access and use rights needs to be recognized.
5. Article 6.18 calls upon government to protect the rights of small-scale fishing communities and their access to traditional fishing grounds and resources.
6. The article calls upon government to protect the interest of indigenous fishing communities against the erosion of their fisheries and livelihood by the growth and expansion of semi and industrial fishing fleets that target the same fishery resources as indigenous fishing communities.

Fisheries Management

1. The core objective of fisheries management is the conservation of fishery resources and their sustainable use.

2. These provisions do not emphasize the social objectives such as employment creation poverty alleviation and food security.
3. However such objective are indirectly addressed through article 7.6.6 which recognize the interests of local fishing communities and indigenous peoples by stipulating that when deciding on the use, conservation and management of fisheries resources, due recognition should be given to traditional practices, needs and interests of indigenous people.
4. These articles, refers to indigenous fishes whose subsistence fishing activities are often in conflict with other interest for eg. Industrial shrimp-trawling, distant-water tuna fishing, tourism development, industrial aquaculture and the creation of non-participatory and exclusive marine protected areas (MPAs)
5. The challenges of fisheries managers such as the difficult trade-off between short-term priorities and long term objectives.

Eg. There are times when the best scientific evidence available points to the need for a reduction in the catch under circumstances where strong social and economic pressures are expected to maintain or even increase the catch.

6. Managers should explore all possible ways of ameliorating social and economic pressures before making decisions to risk the aquatic resources on which the poor depend.

The technical guidelines No. 4 stress.

- The use of traditional structures as part of the fisheries management system
- The recognition of traditional or customary systems of fisheries management at local level when establishing arrangements for management in partnership.
- Guidance to national legislators for incorporation of traditional practices, where management policy includes some formal partnership

Ecosystem approach to fisheries management

This approach builds on current fisheries management practices and more explicitly recognizes the interdependence between human well-being and ecosystem wellbeing eg. Prohibition of destructive practices and development of environmentally safe gear. Other examples include optimal use of energy and problem of sound and pollution.

Development of waste disposal systems in harbors and landing places. Onboard incineration to prevent unnecessary dumping at sea.

The approach assesses the interactions between fish, fishers and elements of the ecosystem and human system relevant to management.

Indigenous people should be the target groups in stakeholder analysis and capacity building.

Precautionary approach and indigenous fishing communities

- 1) All fishing activities should be subject to prior review and authorization.
- 2) There should be a management plan for each fishery.
- 3) Precautionary monitoring of fishing should seek to detect and observe a variety of ancillary impacts (eg. Environmental changes, fish habitat degradation and effects on birds, mammals) using information from indigenous people. Appropriate procedure to process and analyze this information should also be in place.
- 4) Delegating some of the decision making especially area closures and entry limitations to local communities.
- 5) Traditional knowledge to be used to complement other sources of fishery information after necessary scientific analysis.

Participation in fisheries management

- 1) In all fisheries management initiatives and decision making process the right and principle of free prior and informed consent of indigenous people should be considered.
- 2) For improving the management of fisheries government need to develop and strengthen existing partnerships with NGOs.

Access and use rights of fishers and indigenous fishing communities

- 1) Open access requires are not sustainable and hence not promoted by the code.
- 2) However open access restrictors are insufficient to sustain the livelihood of indigenous people if additional measures such as better access to credit and technology are not put in place.
- 3) They should be accessible to microfinance measures and made to strengthen their existing informal savings and credit schemes at micro-level.

Limited access

- 1) Limited access to fishery resources is essential for responsible fisheries.
- 2) The code proposes to give indigenous fishing communities preferential access to traditional fishing grounds and resources
- 3) However if continued fishing by vulnerable communities are not compatible with sustainable fisheries management, then these groups have to be supported in finding alternative livelihood.
- 4) Restriction of fishing activities by closed seasons or closures with respect to certain stocks or geographical areas. Eg. Marine protected areas (MPAs).
- 5) Establishment of MPAs should not encroach on the right of access to fishing areas for indigenous communities. The code promotes for consultation and involvement of the local communities in initiating, developing and managing MPAs.

- 6) Access can be granted to these communities on the basis of a proven history of participation in fishery, a history of responsible fishing etc.

Collective access and use rights.

- 1) Access of local communities to fishing grounds should not be negatively affected by aquaculture development.
- 2) Under collective rights a local community rather than an individual holds exclusive right to harvest in a particular geographical area.

Such rights are the right to

- Harvest a particular stock
- To fish in a particular area
- To use a certain kind of gear or vessel

Traditional knowledge and research

- 1) States should investigate and document traditional fisheries knowledge and technologies.
- 2) In accordance with national due recognition laws and regulations to safeguard traditional practice. Needs and interests of indigenous people should be made.
- 3) States should give priority to undertake research and data collection for improving the scientific and technical knowledge of fisheries.
- 4) Collaborative research projects should be developed involving scientists and indigenous fishing communities.

Conclusion:

- 1) The code does not have a direct reference to indigenous fishing communities but it is relevant to indigenous fishing communities as it views them as part of the category of small-scale and artisanal fisheries.
- 2) The code emphasizes on a participatory approach for indigenous fishing communities. Representatives of indigenous fishing communities and NGOs representing indigenous people should be involved in implementing the code.

Overview on recommendations of the code addressing government that are important to indigenous fishing communities.

In the context of indigenous peoples the state should

- Protect the right of fishers for a secure livelihood.
- Minimize adverse impacts on local communities through aquaculture
- Management measures should take into account interest of subsistence small scale and artisanal fisheries.
- Ensure that coastal area management plans take into account interest of artisanal and subsistence fishers.
- Ensure that aquaculture development does not threaten the livelihood of local communities and access to fishing grounds.

- Recognize the traditional practice and needs of indigenous peoples.
- Ensure that policy legal and institutional frameworks take the needs of coastal communities into accounts
- Investigate and document traditional fisheries.

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Voluntary Responsible Fisheries Management: Cases from Tamil Nadu

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Introduction

As in many tropical developing countries, the fisheries management in India is often intertwined between formal and informal agreements (traditional systems), which are not easily observed (Pidoet *al.*, 1996). Most of these local agreements are semi-official, traditional, and sometimes even oral among different players involved in the activity. Even though all the fishing activities in Tamil Nadu are formally governed by the Tamil Nadu Marine Fisheries Regulation Act, 1983, the local agreements, rather than the Act and other government directives, seem to determine the management of the fisheries. The local agreements or heterogeneous local management systems or voluntary responsible fisheries management are exclusive for a village and do not apply for the nearby villages even though same fishing grounds might be shared. However the Department of fisheries, the District Collector and the Panchayat authorize these local agreements before they come in to order. These informal management systems are highly dynamic providing solutions for newly emerging problems.

The local agreements or heterogeneous local management systems or voluntary responsible fisheries management which is followed in Tamil Nadu coast were: Vembar (time restriction, daily and yearly), Tharuvaikulam - (no trawling only passive gears), Veerapandianpatnam (mechanised boats do not operate for 5-6 months and time restriction, daily and yearly and spatial separation), Tuticorin (time restriction, daily and yearly), Palk Bay and Gulf of Mannar (GoM) region of Ramanathapuram District (three-four day rule) and Gulf of Mannar (GoM) region of Ramanathapuram District (self-regulation in seaweed collection).

The noticed local agreements strive to provide solutions for the three characteristic problems arising in areas where mechanised and traditional fishing vessels exploit the same resource:

1. Mechanised boats often damage the fishing gear of traditional fishermen, causing financial loss to them;
2. Mechanised boats pose danger to the safety of the traditional fishermen: due to collisions between mechanised boats and country boats, traditional fishermen get injured; and
3. The expanded reach and indiscriminating nature of trawling downgrade the marine resources, lowering catch and income of the traditional fishermen and endangering sustainability of the resource. (Haastrecht & Schaap, 2003)

i) Vembar, Tuticorin district of Tamil Nadu

Management intervention: Time restriction, daily and yearly

The mechanised boats are employed for **only four to six consecutive months per year**. The abundance of target fish species, the trawling ban in April - May, and the beginning of the rough season determine the length of the fishing season. Although the start of the peak season for fishing starts in April, the boats are restricted by the trawling ban, and they can only start fishing in June. The rough season generally begins in November. The fishing season thus last from June to September or November. During the remaining months, there will not be enough fish to make the fishing operation profitable, while during the rough season it is too dangerous at sea, and there is a higher risk of occurrence of cyclones. Mechanised boats are operated six days a week, from Monday to Saturday. As the majority of the fishermen in Tuticorin district are Christians, Sundays are without exception, free days. The time that the boats stay at sea, is dependent on the season, targeted species, and the visited fishing grounds. The following timings followed were:

- During June the boats leave the shore at **1 a.m., and return at 5 p.m.**;
- From August onwards they will leave at **5:30 a.m. and return at 12 p.m.**

Night fishing is thus common practice. The mechanised boats operating off Vembar exclusively apply bottom trawling. There are two types of bottom trawl nets: one specifically for prawn fishing, used from June to August, with small mesh-size at the cod-end, and one used for capture of demersal fish, which has larger meshes. The boats from Vembar mainly exploit the prawn fishing grounds that are close to a place called Erwadi, located in Ramanathapuram district. Boats from Tuticorin and other areas are increasingly coming to these same fishing grounds. (Haastrecht & Schaap, 2003)

The existing local agreements in Vembar only seem to concern, to some extent, the time schedule for mechanised boats: the time schedule related to seasons was said to be a result of a local agreement. If any, agreements present are not official written agreements, but come as oral agreements between the mechanised boat and traditional fishermen. Yet these agreements have to be approved by the boatowner and fishermen association in meetings organised by the village panchayat. Due to these oral agreements, there are no long lasting conflicts between the mechanised and traditional fishermen. When a conflict, due to damages of traditional fishing gear and the like, arises, it is settled immediately amongst the involved people.

The local agreements do not extend to neighbouring fishing villages, although the same fishing grounds are largely shared. When there are conflicts with fishermen from different villages, the panchayats will organise peace meetings and in this way try to settle the dispute. Most conflicts will occur between mechanised boat fishermen and the traditional fishermen. The conflicts within the mechanised sector, including mechanised boat fishermen from other villages, are negligible. (Haastrecht & Schaap, 2003)

ii) Tharuvaikulam, Tuticorin district of Tamil Nadu

Management intervention: no trawling only passive gears

As in Vembar, mechanised boats are not employed all year round. During the rough season, on rainy days and during the ban period, the boats will not be operated for the same reasons mentioned in the Vembar section. The traditional fishermen on the other hand, will operate their vessels year round. The boats are operated six days a week, Sunday is a rest day. **The fishermen are not bound to a time schedule:** departure and return of the boats depend on the targeted species and the type of nets used. For instance, nets for crab capturing are set in the afternoon and collected the next day. When finfishes are targeted, the boats will leave at 6 or 7 p.m. and return in the early morning, around 6 a.m. Frequently, the boats stay out for multiple days, usually remaining at sea for three nights. Also here, night fishing is common practice. The mechanised boats in Tharuvaikulam do not use the trawling method and operate only gill nets. The fishing grounds are currently some 30 nautical miles away from Tharuvaikulam. Fishing is carried out in different areas, which are frequently shifted depending upon the catch. Boats from Tuticorin go to the same areas. (Haastrecht & Schaap, 2003)

In contrast to the other localities, **the mechanised boats from Tharuvaikulam do not employ the trawling method. A local agreement between the mechanised and traditional sector restricts the mechanised boats to the use of gillnets. Bottom trawling is not allowed under any circumstance.** The decision on the banning of the trawling technique was based on the fact that trawling affects the resource in a negative way, in contrast to passive gears, like gill nets. All respondents agreed that trawling causes damage to the marine ecosystem. Moreover, as trawling also causes damage to the gear and the crafts of the traditional fishermen, the ban on trawling is also a method to avoid conflicts between the two user groups. The agreement on prohibiting trawler fishing was apparently an oral agreement. The fishermen from other locations (Tuticorin mainly) are not allowed to use trawling off Tharuvaikulam. When fishermen from Tuticorin do operate their trawling vessels near Tharuvaikulam, it is said that officials from the Fisheries Department arrange their removal and send them back to Tuticorin. Due to the fact that mechanised boats only use gillnets, there are hardly any problems and conflicts on the local level among the traditional and mechanised boat fishermen from Tharuvaikulam, even as they exploit at the same fishing grounds. If any, problems that inevitably would appear are settled with help from the village panchayat, or an Assistant Director of the Fisheries Department. However, most problems emerge between mechanised boat fishermen from Tharuvaikulam and Tuticorin. The trawlers from Tuticorin exploit the same fishing grounds and cause damage to the gillnets. (Haastrecht & Schaap, 2003)

iii) Veerapandianpatnam Tuticorin district of Tamil Nadu

Management intervention: Mechanised boats do not operate for 5-6 months, time restriction, daily and yearly and spatial separation

As in Vembar and Tharuvaikulam, **the mechanised boats are employed only 5-6 consecutive months a year**. They are operated from June to October - November and berthed for the rest of the year in Tuticorin fishing harbour. The traditional boats are operated round the year. Hence most of the crewmembers (and some boat owners too) employed on mechanised boats will work on traditional fishing crafts in the remaining months. Typically, the mechanised boats berthed in Tuticorin harbour will not be operated during these months. In general, fishing operations are carried out six days a week (Monday to Saturday). The boats have a regular time schedule: **all boats leave the shore at 6 a.m. and return between 9- 9.30 p.m.** Hence, they do not undertake night-fishing operations. The mechanised boats use bottom-trawl nets, sometimes alternated with hook and line. Some fishermen only use one type, both for fishing on prawns and finfishes, (with mesh sizes ranging from 30 mm between knots at the cod end, to 130 mm between knots at the upper end). Others use a different net for fishing on demersal fishes, these nets have bigger mesh sizes than the previous net. The fishing grounds exploited by fishermen from Veerapandianpattinam are also used by mechanised boats from Tuticorin and other areas. Compared to ten years ago, the fishing grounds are located further from the shore. The fishing grounds are shifted frequently, depending on the catch. (Haastrecht&Schaap, 2003)

In Veerapandianpatnam mechanised boats do not operate for 5-6 months in a year as dictated by the local agreements. (November-June) Although in Tuticorin harbour area all the local agreements that were existent came to a standstill after September 2002, following an accident, which involved a mechanised vessel colliding with a vallam from Punnakkayalvillage near Tuticorin harbour. This later broke in to a serious problem as three traditional fishermen died in this incident and all the peace talks failed. Since then the Act has been strictly implemented as was demanded by the traditional fishermen. However the fishermen are trying to formulate new local agreements and requesting the fisheries department to acknowledge it as the trawler fishermen find it unprofitable to go for fishing as per the timings mentioned by the act which are implemented now. Paying heed to this request the Department of Fisheries has relaxed the restrictions on timings from 9.00 pm to 11.00 pm for some time. Though the diverse local agreements constrain government intentions to enforce a uniform law, they nevertheless are very effective when it comes for enforcement and at the same time serve as effective tools for conflict management. Given such agreements, which are in place, which vary from village to village, the key is to identify the most effective way of sustaining the resources with minimum social cost inflicted on the people belonging to the community. (Haastrecht&Schaap, 2003).

This is the only village in the district where a local agreement between the two user groups restricts the employment of mechanised boats to 5-6 months a year. When fishermen do want to go for fishing with a mechanised boat during the months between November and June, they have to ask permission from the traditional fishermen. Moreover, still they are only allowed to operate their boats from Tuticorin harbour since the boats have

to be berthed there between November and June. This agreement seems to be in place since 15 or 20 years ago. One fishermen framed that this time restriction on the number of months allowed for trawling, was a court order to protect the traditional fishermen. It is not clear whether this agreement really was issued in court, or agreed on by the village panchayat. Most mechanised boat fishermen work in the traditional sector for at least six months per year. **Mechanised boats are not allowed to fish close to the shore, and are restricted to areas where the bottom is at least over 5.75 meter below the water surface. In their turn, the traditional fishermen have to stay close to the shore, and are not allowed to fish in areas where mechanised boats can operate.** In general local agreements are arranged between the cooperative fishermen society (for traditional fishermen) and the mechanised boat fishermen in presence of the village panchayat. When possible, problems between traditional and mechanised boat fishermen are directly solved among themselves. However, conflicts involving fishermen from Veerapandianpattinam and other fishing villages in the district are not solved that straightforwardly. (Haastrecht&Schaap, 2003).

iv) Tuticorin, Tamil Nadu

Management intervention: Time restriction, daily and yearly

In Tuticorin, the mechanised boats fishermen have their own harbour, while traditional fishermen are in general concentrated in nearby villages Thirespuram and Punnakayal. Another considerable difference with the other villages is that, with regard to the time schedule, the Act of 1983 is strictly implemented. The mechanised boats from Tuticorin operate the entire year, except during periods with very bad weather conditions. Usually this is in November; the sea will be very rough and dangerous, and most mechanised boats will not go for fishing. As is the case in the other villages, the boats will not be operated on Sundays. **The timings are strictly managed by the Act: the boats are allowed to leave the harbour at 5 a.m. and have to be back by 9 p.m.** The boats in Tuticorin only practice bottom trawling. Tuticorin trawlers mainly exploit the resource from the trawling grounds off Punnakayal and Manapad to the south and off Erwadi to the north of Tuticorin (Rajmani&Manickjara 1995). These fishing grounds are shared with many other fishers from villages in Tuticorin district.

The fishing customs of mechanised boat fishermen in Tuticorin are now to a great extent determined by the rules in the Act. However, until September 2002 the fishing customs were determined by an extensive set of local agreements. Most of these agreements were designated to provide solutions for problems between the traditional and mechanised boat fishermen. These agreements provided rules on the number of months the mechanised boats were allowed to fish, rules on timings, spatial separation of mechanised and traditional boats, rules for closed seasons and rules on conflict solving. The local agreements in power in and near Tuticorin are thus officially written documents. In order to arrange the agreements, the Assistant Director or Joint Director of the Fisheries Department organise meetings with the leaders and other important persons from the boatowner association and the cooperative fishermen society. Usually also a police officer or the District Collector will be present. When the agreements are accepted, all groups have to sign the written agreements. According to the mechanised boat fishermen from Tuticorin, problems between them and mechanised boat fishermen from other villages do not exist. Most conflicts arise between the mechanised boat fishermen and the traditional fishermen. Especially conflicts

between fishers from Tuticorin and Punnakayal have a long history. Serious conflicts between traditional and mechanised boat people are settled by the Assistant Director and the police. Small problems between the traditional and mechanised boat fishermen are settled among themselves or by leaders of the Boat Owner Association or Co-operative Fishermen Society. (Haastrecht&Schaap, 2003)

v) Palk Bay and Gulf of Mannar (GoM) region of Ramanathapuram District
Management intervention: Three-Four Day Rule

In the view of the major conflicts took place between mechanized fishing vessels, specifically those using trawlers, and the small-scale fishing vessels, the three-four day rule was implemented in the Palk Bay and Gulf of Mannar (GoM) region of Ramanathapuram District from 1993, based on the decision taken at a District Collectors' meeting. It allows mechanized fishing vessels to fish for three days a week, while small-scale fishers could fish on the remaining four days. The 'three-four day rule' system was initiated as part of district administrative orders to maintain law and order in the district, is one of the important fishing regulations being implemented by district-level officers. Similar kind of rule was implemented during 1977 in the Pudukkottai and Thanjavur Districts. The decision was to implement different regulations for the northern and southern parts of the districts, and also in different seasons. The regulations for the northern part of the district, that is, Palk Bay, are strictly implemented by the District Directorate of fisheries officials, whereas in the case of the GOM, the regulations have been formulated by fishermen's organizations and boat owners' associations themselves, to avoid conflicts in the fishing grounds. This regulation is also followed by the non-mechanized fishermen, who observe specific times for setting sail and returning to shore.

vi) Gulf of Mannar (GoM) region of Ramanathapuram District
Management intervention: Self-regulation in seaweed collection

- i. As a community initiative since 2006, in the Palk Bay region, seaweed collection (*Gelidiella acerosa*) is banned during the month of October to January, whereas in Gulf of Mannar region seaweed (*Gelidiella acerosa*) collection is banned during the month of March to June.
- ii. Similarly the seaweed (*Sargassum* spp.) is collected only during the month of July to October in a year.
- iii. In some villages collection of seaweeds is restricted to 12 days in a month, with Friday designated as no-collection day.
- iv. Another community initiative is the banning of metal scrapers for collection of seaweed. Traders have been asked not to buy seaweed collected with scrapers.

Conclusion

The local agreements or heterogeneous local management systems or voluntary responsible fisheries management is primarily instigated to the protection of traditional fishermen: if they accept an agreement with the mechanised boat fishermen, the Fisheries

Department does this as well. Besides that, local agreements can avoid conflicts between fishermen, since fishermen will be more dedicated to their own rules than to government regulations. In consideration of local conditions, there is variation in fishing customs in the different villages. For this reason regulations can differ, and that is why local agreements are accepted alongside the act. When local agreements work well, the Act behaves as basic background for local fisheries law rather than as regulating body.

Common Resource pools, like fisheries, managed by the community, which holds the right over decisions regarding the resource exploitation, is a much better option than open access, government and private ownership of the resource (Ostorn, 1999). Cases like Tharuvaikulam show the effectiveness of community-managed resources in the task of ensuring sustainability. A decentralised community management system is the need of the hour to tackle the problems that will be faced by the fishing community in the near future.

A long and unfinished voyage: The SIFFS Story

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SIFFS

Introduction

Fishing is an occupation that predates settled agriculture. It has its origins in humankind's hunter gatherer stage of life. In India marine fishing is practiced over centuries over a 6000 km coast line. It is a caste based occupation with around 3-4 castes specializing in marine fishing in each maritime state. Fishing castes are among the most backward and are marginal to society in most states. Gendered division of labour prevailed with men going to sea and the women work in the post -harvest sector. In India, fishermen lost control over their catches as soon as they bring it ashore; middlemen/merchants who advance money took control over the catch. Post- independence, various Government interventions led to the creation of a "mechanized sector" based on "trawling" for export varieties. Trawlers and traditional or "artisanal" fishermen were in perpetual conflict for resources in most states of India. The artisanal fishermen (80% of the work force) were also responding to the competition with adoption of motors and improved fishing methods. Artisanal fishermen still remain one of the most vulnerable and marginal groups in Indian society, perhaps second only to the tribals.

Artisanal fisherfolk: A Glimpse





The Marianad model and formation of SIFFS

A new fishing village was created in Marianad in Trivandrum district through the initiatives of a clergy run “community development project”. In order to prevent the market related exploitation through middlemen commission rebates and non- payment of full amount, there was a felt need for formation of a Cooperative with the entry of young persons in the late 60s. The Marianad cooperative was formed in the year 1970. Through the formation of the co-operative, fishermen were able to control over beach level auction or the first point of sale. Society salesman conducted auction rather than middlemen. Cash

payments were through society. Source deductions for savings and loan repayment. Integration of marketing, credit and savings at village level were the key features of the model. With the success of the Marianad cooperative, other villages also show interest and societies came up in a few more villages in the mid 70s. The activists formed the PCO, a secular NGO and started working all over district in 1977. Through this society formation got a boost and the neighbouring Kanyakumari Diocese picks up idea in 1973 and started “sangams”. By 1980 around 10 societies each in Trivandrum and Kanyakumari districts were formed. But Trivandrum societies faced the problems in marketing of export species by way of exploitation by traders supplying nets. PCO refused to start business, encouraged fishermen to form own federation to start business activities. Trivandrum societies formed the federation and called it SIFFS and the SIFFS came into existence in December 1980.

Marketing experiences: lessons learned

There were differences in urban and rural demand for fish. Dispersed nature of production and consumption created problems in marketing. Since women played a significant role in local fish marketing, they faced difficulties in retailing in cities. Among the export varieties prawns proved difficult to market and cuttlefish and squid showed good potential in the export market. Direct links were established with export company by-passing two links in the chain. However, problems of pricing, bulk landings, spoilage, seasonality of operations, problem of maintaining staff and infrastructure during off season made marketing a difficult venture. Eventhough the market intervention was very useful, it was difficult to sustain without extraordinary effort by committed and brilliant team and to manage the risks involved. With regard to marketing in internal markets located at faraway places, pricing and selection of markets were problems and certain amount of speculation and art was necessary and it was feasible only under certain circumstances.

The changed scenario in the early 80s

SIFFS marketing interventions were all based on 70s experiences of glut landings and large losses by fishermen. Competition with mechanised trawlers started in late 70s which got intensified in early 80s. Greater share of export species gone to the mechanised sector and most of the table fish for Trivandrum market came from mechanised landing centres. Depletion of near shore resources resulted in decline in the catches of the traditional sector. Bulk landings occurred only on rare occasions and there was more competitive situation between merchants and companies. This has necessitated technological interventions for the traditional fishermen. The church project at Muttom introduced plywood boats and later Out Board Motors (OBMs) were introduced in 1980.

SIFFS and new technology for fishing

The early success of the plywood boats led to discussions on future course of boat building and SIFFS reluctantly agreed to take the lead in building boats for Kerala market. First SIFFS boat yard was set up for dugout substitution to plywood boats. Imported OBMs running on kerosene brought many problems due to poor service facilities and lack of fishermen capacity to manage motor. SIFFS OBM programme launched in 1984.

SIFFS has also undertaken other activities like R&D to protect the interests of “artisanal” fishermen, initiatives on bank linkages, involvement in society supervision and auditing and sharing of responsibilities with PCO for the health of the society network. The

Quilon societies in 1983 integrated boat supply and net supply. The success of technological interventions introduced a new dimension to the work: sectoral orientation vs. member services.

Societies in each district had federation. District federations took over the NGO role in organising, monitoring and guiding village societies. Fish marketing and supply of nets/requisites were the business of district federations. Credit linkages and other educational and welfare roles were the responsibilities of the district federation.

The new SIFFS

SIFFS diversified its activities like marketing, net supply and other services to member societies to the newly formed Trivandrum federation. SIFFS also focussed on long term interests of artisanal fishermen, especially with regard to technology development and its commercialisation. While District federation took care of day to day needs of member federations, SIFFS played other roles like export or some other large scale intervention in common to the 3 districts according to necessity. SIFFS was also responsible for expanding society network in new areas as per necessity.

SIFFS: The five phases

- 1986-1990: Technology phase
- 1991-2000: The integration phase
- 2000-to 2004: Expansion/diversification phase
- 2005-2008: Tsunami phase
- 2008-present: Restructuring for long term sustainability

The technology phase (1985-91)

During this phase, great emphasis was on R&D. New boats were designed and plywood boat technology was introduced in north Kerala. The work on artificial reefs has begun. Out Board motor training was given to fishermen. Boat building became viable and a commercial success and SIFFS got a brand name. District federations grew and developed, but marketing couldn't prove successful.

The integration phase (1991-2000)

During this phase change of guard at District level occurred and NGO links were broken. There was Greater emphasis on SIFFS for external linkages and ideas. The economic reforms began in 1991 brought new opportunities. OBMs were imported and networks of OBM service centres were opened. Increasing shift to plyboat-OBM combination by members made SIFFS critical for day to day life of fishermen.

During the credit crisis in the mid 90s SIFFS jumped to the microcredit bandwagon. It also expanded its activities to Malabar. The Tirunelvely and Tuticorin fishermen federation and shark fishermen association were also integrated. Ice plants were opened up under SIFFS and marketing interventions were also continued. A series of publications documenting vital aspects of fisheries sector were brought out. It has also involved in the

advocacy work and formation of Alliance for Release of Innocent Fishermen (ARIF) to tackle Indo-Sri Lanka border issues. As a high profile organisation, it was pushed into the limelight with high member stakes and increasing integration of 3 tier structure with greater degree of mutual dependence.

Expansion/Diversification phase (2001-2004)

There was growth in areas of strength like OBM, boat building and credit during this phase. Credit programme fuelled membership stability and growth in most districts. However, there was set back in Tirunelveli and Tuticorin federation. Activities began in Andhra Pradesh and Nagapattinam and Ramnad Districts of Tamil Nadu. It also played a crucial role in strengthening of shark fishermen association and entry into deep sea fishing.

Expansion/Diversification phase

Initiatives for alternative employment was began in this phase. It formed tie-up with Canadian firm for software development and training. It also started working among fisherwomen. Initial discussion and plans for fisheries management were also started. ARIF work among trawlers of Rameshwaram; Indo Sri Lankan exchange was one such initiative. Eventhough export of seafood under 'social labelling' was also undertaken, it was not successful.

However there were some structural issues. The unviable district federations depended on external grant due to declining fund raising capabilities. Failure of commercial activities at district level led to reversion of roles to SIFFS. There was also depletion of talented manpower in district federations. The structure has become unstable and perhaps inappropriate. There were also issues related to non- involvement of crew and lack of organic link with women's groups.

Tsunami Phase 2005-2008

SIFFS was recognised as the largest NGO on the coast, despite having its presence in only four of the 8 affected districts in Tamil Nadu, the worst affected state by the Tsunami. However SIFFS had presence in the two worst affected districts (Nagapattinam and Kanyakumari). SIFFS mainly focused on activities in those two but limited services were provided to other areas also. SIFFS acted as a direct service provider of relief and rehabilitation to fishing communities. In partnership with NGOs working in other sectors SIFFS had involved in coordination of relief and rehabilitation activities. SIFFS also intervened in long term development activities.

SIFFS utilized tsunami as an opportunity to pursue long term development work among fisherfolk in affected area. New societies started in Nagapattinam and Pondicherry. 1200 small boats organised for marketing and 6 crore worth of fish sales by new societies after tsunami. Boat building infrastructure and motor repair services were expanded. New Boat yards, repair centres, ice plants being put up on east coast. Distribution of ice boxes were done in collaboration with Government. Village Information Centres were set up in Nagapattinam and Kanyakumari Districts. New models for off shore fishing with inboard diesel engines introduced in Nagapattinam and new canoe for inland fishermen. New Community based fisheries management initiatives were also undertaken building on the basis of traditional village level organisations of the fishing community.

Restructuring phase: 2008-present

Tsunami phase represented a huge scaling up for SIFFS, without resolving its original problems. By 2008 most donors pulled out creating a funds crunch. Many activities were scaled down due to lack of funds. Restructuring involving a decentralization of activities and focus on financial sustainability became necessary.

SIFFS Today

At present SIFFS has 150 primary societies in 12 districts of Tamil Nadu and Kerala. It has only a marginal presence in Andhra Pradesh. 8000 fishing boats with workforce of 30,000 fishermen are under SIFFS. Fish sales by society network (2007-08) amounted to Rs.80 crores. Credit portfolio at SIFFS level was Rs.15 crores . Overall credit portfolio at society level was Rs.20 crores . There is a network of 18 boat yards from Mangalore to Kakinada; 500 boats/year capacity. It has a network of 25 OBM service centres from Gangolli to Chidambaram. SIFFS is the largest distributor of Out Board Motors in India; dealer for Suzuki OBMs. It owns two ice plants and three more are coming up. New development initiatives were begun in the marketing sector. Over 5000 fisherwomen get support through fisherwomen's federation. It also plays a crucial role in creation of Alternative employment through training on carpentry, mechanics, and computer training in collaboration with corporates like L&T. It has got an increasing role in advocacy and lobbying for the fishermen. It also supports the fishermen trade union. It has also undertaken major fisheries management initiative in collaboration with FAO. The Total beneficiaries of system at present is 60,000 fishermen and women covering a population of 3.0 lakhs.

The future

The future thrust areas are restructuring and ensuring higher financial stakes of members. De-linking the cooperative and promotional agency roles of SIFFS is also necessary. Further expansion of society network to east coast (TN and AP) is required. Resolve the failures in marketing through moving up the value chain, developing a fisheries management system (co-management) and finding ways of crew participation as well as organic link with women's groups are other major thrust areas. Over the years SIFFS had played significant roles in changing the techno-economic and socio-political profile of traditional fishermen in the country. However the issues with regard to scale and replicability and attracting professionals into co-operatives like SIFFS need to be given priority for its further strides in the fisheries sector of the country.

Network for Fish Quality Management and Sustainable fishing (NETFISH)

Joice V. Thomas and Afsal V.V

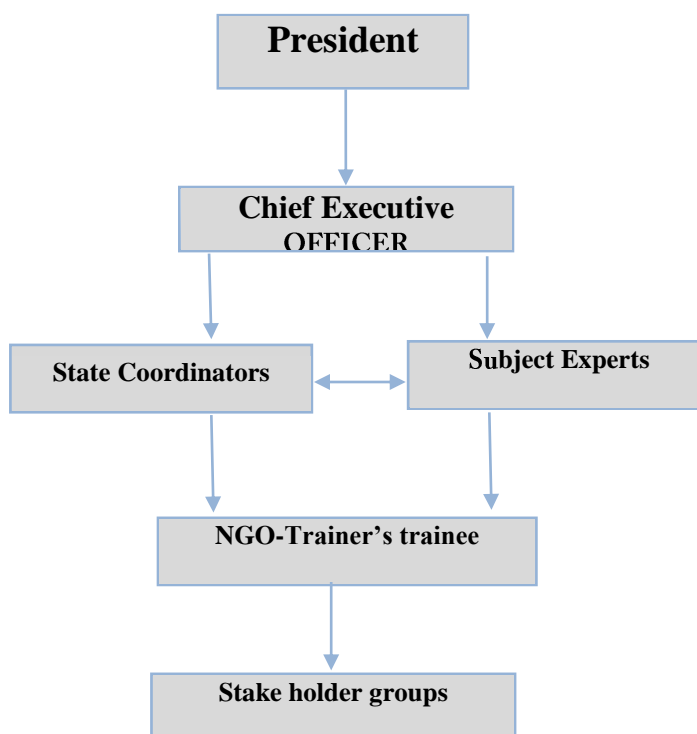
NETFISH, MPEDA, Cochin

Introduction:

Network for Fish Quality Management and Sustainable Fishing (NETFISH) is a society formed in 2006 under the aegis of Marine Products Export Development Authority (MPEDA), Kochi. The Society is registered under the Travancore–Cochin Literary, Scientific and Charitable Societies Registration Act, 1955. NETFISH, the extension arm of MPEDA, stands for improving the quality of fishery products exported from the country and the sustainability of fishery resources as well. The major objectives of NETIFSH is to empower fisheries sector by imparting knowledge to fishermen, fisherwomen, processing workers, technicians, etc on fish quality management ,conservation of fish resources and sustainable fishing. To achieve this aim, NETFISH organizes grass root level awareness programmes among fisher folk and other stakeholders in all the maritime states of the country thereby changing their mindset towards fish quality management and responsible fishing.

This society is headed by the president, Ms.Leena Nair IAS, the present chairman of MPEDA since year 2009 and the various activities of NETFISH is controlled by the Chief Executive officer with the help of Executive committee comprising 18 members including senior officers of MPEDA, directors of CIFT and CIFNET and representatives of various NGO members in NETFISH from the different maritime state of the country.

Organogramme:



Executive committee and Annual General Body

The management and control of the Society is entrusted to the Managing Committee called as the Executive Committee and the management is carried on in accordance with the Rules & Regulations. The Executive Committee members of NETFISH for the year 2013-14 are as given in Table 1.

Table 1. Executive Committee members of NETFISH (2013-14)

S.N	Name	Address
1	Ms. Leena Nair I. A. S	Chairman, MPEDA, Cochin
2	Shri. N. Ramesh	Director (M), MPEDA, Cochin
3	Shri. Mohana Sundaram	Director, MPEDA, Cochin
4	Shri. B. Sreekumar	Secretary, MPEDA, Cochin
5	Shri. Avinash P. Joshi, IAS	Director, MoCI, New Delhi
6	Dr. Sreenivasa Gopal	Director, CIFT, Cochin
7	Shri. R. C. Sinha	Director, CIFNET, Cochin

8	Shri.Asha C.Parameswaran	Jt. Director (Q.C.), MPEDA, Cochin
9	Dr. Joice V. Thomas	Chief Executive, NETFISH, Cochin
10	Shri.A.J.Tharakan	President, SEAI
11	Shri. V. Vivekanandan	SIFFS, Thiruvananthapuram
12	Shri. Harekrushna Khataei	RPRDS, Odisha
13	Shri. Venkatesh Naik	SCODWES, Karnataka
14	Shri. M.A. Sekar	SOHES, Chennai, Tamil Nadu
15	Shri. Pardha Saradhi	SEARCH, Andhra Pradesh
16	Shri. N. B. Boghani	Manava Vikas Sevabhavi, Maharashtra
17	Shri. Tarun Kumar Giri	The Science Association of Bengal, West Bengal
18	Shri. M.S.H. Sheikh	Brackish Water Research Centre, Gujarat

The annual general body of NETFISH comprises all the members of NETFISH including the staff, members of Executive Committee and members NGOS and are generally met once in a financial year to appraise the activities of NETFISH and its general account.

Major objectives

The major objectives of NETFISH are given below

1. To function as the focal point for upgrading the technology and quality management of fishing and fish processing sectors at the grass root level.
2. To organise appropriate training programmes on fish quality management and conservation of fishery resources in all the maritime states of India.
3. To network with stake holder organisations by inducting their representatives in to the general body of NETFISH
4. To assimilate, absorb and transfer technologies related to capture fisheries.
5. To develop systematic linkages between international, national/state/district institutions of excellence in the field of extension and marketing.
6. To generate internal resources by offering various services to the sector and to member societies
7. To facilitate public or private investment in infrastructure development.
8. To donate funds belonging to the society for any public cause of national or regional importance
9. To promote capacity building for stake holders, in planning, marketing, technology dissemination, processing, etc and thereby facilitate their empowerment
10. To acquire from any person, firm, body corporate or government departments or agencies in India or abroad, technical informations, including know-how, process, operating data, plans designs, blue prints or any other information or assistance required for conducting extension training programmes and to transfer such technical know-how, plans designs and other relevant information to fishermen/processing

workers/technicians through the extension training programmes in various maritime states of India

11. To disseminate knowledge relating to fisheries stocks among fishermen and educate them in conservation of resources and sustainable fishing. In pursuance of the goal, the Society shall popularize alternative means of livelihood for fishermen in the fishing sector.
12. To induct competent and experienced technical experts and other skilled manpower available in the fisheries sector, who opt voluntarily to be a member in the Society, without any restriction of caste, age and sex for executing the extension training programmes
13. To provide consultancy and technical services to the entrepreneurs of the seafood industry related to quality aspects of the pre-processing and processing of the seafood
14. To bring out specific technical publications related to extension training programmes by collecting up-to-date technical information and data, on relevant subjects related to seafood industry
15. To undertake commercialization of the technologies developed in fisheries research institutes, by joining hands with the concerned institutions.

NETFISH staff

NETFISH staff comprises mainly the Chief Executive at the head office Kochi and 10 state coordinators in the various maritime states in India as given in the table below.

Nongovernmental organizations are inducted as member NGOs in NETFISH and they will be trained and used as the trainers in NETFISH for conducting various activities of NETFISH.

No.	Name	Designation	Office
1	Dr. Joice V Thomas	Chief Executive	NETFISH, Vallarpadam
2	Aliamma Kuriachen	State Coordinator	NETFISH, Vallarpadam
3	Sangeetha N.R.	State Coordinator	NETFISH, Vallarpadam
4	Narayana K.A	State Coordinator	MPEDA SRO, Mangalore
5	Santosh Kadam	State Coordinator	MPEDA RO, Mumbai
6	Jignesh Visavadia	State Coordinator	MPEDA RO, Veraval
7	Atanu Ray	State Coordinator	MPEDA RO, Kolkata
8	Subrakanta Mohapatra	State Coordinator	MPEDA SRO, Bhubaneswar
9	Hanumatha Rao	State Coordinator	MPEDA RO, Vizag
10	K.Anandan	State Coordinator	MPEDA RO, Chennai
11	Dr. A.Murugan	State Coordinator	MPEDA SRO, Tuticorin
12	Afsal V.V.	Research Assistant	NETFISH, Vallarpadam
13	Remya K.R.	Accountant	NETFISH, Vallarpadam
14	Swapna Cleatus	Accounts Assistant	NETFISH, Vallarpadam

Methodology

NETFISH designed its activity on a three tier system by

1. Giving a variety of training programmes repeatedly in selected places as an effort to change the mindset of people 2. Practical demonstrations of different aspects hygienic handling of fish and conservation by organizing coastal cleanup programmes, mass boat cleanup programmes ,biodiversity day celebrations, etc with the cooperation of member NGOs, stakeholder groups and Govt. officials 3. Meeting and discussions with various concerned Government agencies like Harbour Engineering Department, State Fisheries Department, National Fisheries Development Board, etc to develop infrastructure facilities at harbour and landing centers. NETFISH is liaised with state as well as national level extension agencies to network and implement its goal much effectively. Stat coordinators of NETFISH maintain a healthy relationship with local community leaders.

Various Non Governmental Organizations (NGOs) have been selected as members in NETFISH considering their past records on conducting fisheries development programmes. Personals from these member NGOs are being trained on various fisheries extension porgrammes with the help of reputed fisheries institutions /Universities /Departments/ Scientists, etc are utilized for conducting various extension programmes among fisher folk. Both theory and practical classes on above mentioned topic are being arranged for fishermen.

Activities

NETFISH's extension training programmes dealt with two major aspects. One is fish quality management and the other is consecration and sustainable fishing

Topics in Fish quality management

The various topics covered in the extension programmes under fish quality management are

1. Hygienic handling of fishes onbaorod
2. Hygienic handling of fishes at fishing harbours/landing centres
3. Hygienic handling of fishes in pre -processing centres
4. Production of good quality dry fish
5. Hygienic harvest of fishes from aqua farms.

Topic in conservation and sustainable fishing

The various subjects covered under the conservation and sustainable fishing are

1. Conservation of coral reefs
2. Conservation of mangroves
3. Conservation of marine turtles
4. Bycatch reduction
5. Mesh size regulation
6. Prevention of Juvenile fishing
7. Destructive fishing practises
8. Eco-freindly fishing methods
9. Responsible fishing
10. Fishing holidays and its importance
11. Marine pollution
12. Unscientific fishing practices
13. Marine protected areas

Types of programmes

NETFISH conducts a variety of programmes among fisher folk and the major ones are

1. Onboard training programmes
2. Harbour & village trainings
3. Pre-processing centre training s
4. Dry fish workers trainings
5. Aquafarm trainings
6. Medical camps
7. School children programmes
8. Rallies/ Jathas
9. Door to door awareness camps
10. Street plays
11. Beach cleanup programmes
12. Harbour cleanup programmes
13. Mass boat clean up
14. Mangrove plantation camps
15. Workshops and stakeholder meetings

Extension tools developed

NETFISH has developed a variety of extension tolls such as documentary films, animation films, training manuals, posters, leaflets etc on different topics and are being utilised in the programmes. These tools were produced in 10 languages

Documentaries:

1. Hygienic Handling of Fishes Onboard
2. Hygienic Handling of Fishes in Harbours & Landing Centers
3. Hygienic Harvest of Shrimps in Aquafarms
4. Sustainable Fishing and Conservation of Fishery resources
5. Hygienic Handling of Fishes at Pre-processing Centers

Animations

1. Good Practices for Better Price
2. Conservation of fishery resources
3. An Escape to the depths

Posters

1. Today's Juveniles Tomorrow's Wealth
2. Wash fish in good quality water
3. Never carry fish in open and without ice
4. Always use shovel to handle fish
5. Carry enough ice when going for fishing
6. Use solar fish drier for good quality dry fish
7. Clean your boat before and after fishing
8. No...No...I don't need this fish, you handled it unhygienically
9. Fish : Ice
1kg : 1 kg
10. Who Spoiled it?

Charts

1. Good Practice Onboard Fishing Vessels
2. Good Practices In Preprocessing Centre
3. Good Practices In Fish Landing Centres

Leaflets

1. Juvenile Fishing
2. Marine Turtles
3. Onboard handling of Fishes
4. A Good Fish Market
5. Eco-friendly Fishing Methods
6. Fish Handling at Landing Centers
7. Responsible Fishing
8. Bycatch reduction Measures
9. Mangroves
10. Coral Reefs
11. Pollution at Fishing Harbours
12. Fish Handling at Pre processing Centers
13. Ice and Fish
14. Good Practices In Shrimp Farming
15. Mesh Size Regulation
16. Overfishing
17. Personal Hygiene

Training manual

1. Fish Quality Management & Conservation of Marine Fishery Resources

Programmes conducted

NETFISH works in all maritime states of India and conduct repeated training programmes at areas in and around selected harbours and landing centers in these states. So far, NETFISH has conducted around 16725 extension programmes of various types, benefitting more than 6 lakhs stakeholders belonging to different groups.

Type of Programme	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
	No: of programmes conducted							
Fishermen	604	1804	1683	1643	1593	1223	563	9113
Onboard	56	108	206	204	233	241	41	1089
Pre-processing & Processing centres	239	276	238	273	242	195	69	1532
Aquafarm	9	33	90	131	147	87	..	497
Dryfish	33	92	112	110	138	137	12	634
Special Programmes	30	369	497	435	791	503	151	2776
Catch Certificate campaign	..	..	875	..	..	..	..	875
Boat Reg. Campaign	..	..	..	209	..	..	..	209
Total	971	2682	3701	3005	3144	2386	836	16725

Major Achievements

- Development of harbour management societies in fishing harbours
- Introduced regular cleaning schedules at various harbours and landing centers
- Bamboo baskets are replaced with plastic baskets, partially or completely in all selected fishing harbours of India
- Involved in development of infrastructure facilities in harbours and landing centres
- The overall hygienic conditions has considerably improved in fishing vessels, harbours and landing centers of selected regions of NETFISH
- Govt. of Gujarat started supplying free 40mm square meshed cod ends to fishing vessels in all the fishing harbours of the state as result of a series of meetings by NETFISH with State fisheries officials
- Due to concerted effort of NETFISH in Gujarat, boat owners stopped trawling from April 30th onwards to avoid the capture of juvenile ribbon fishes at Mangrol, Veraval and Vanakbara fishing harbours, much prior to the regular trawling ban period from June 10th to 15th August imposed by Govt.
- NETFISH could invite the attention of several Govt. agencies such as HED, State fisheries department, Port, etc., towards fishing harbours development, conservation and sustainable fishing and to initiate arduous steps towards this.
- NETFISH could attain the faith of fishermen and could maintain a healthy relation with different stakeholder groups in the fisheries industry



Role of Krishi Vigyan Kendra (KVK) In Fisheries Extension

Shinoj Subramnannian

Programme Co-ordinator/Sr.Scientist

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Evolution and mandate of KVK

The Krishi Vigyan Kendras (KVK) in the country was established in 1974 with the first one at Pondicherry subsequent to the detailed discussions and studies followed by the recommendation of the Education Commission (1964-66), Govt. of India. The initial objective was to establish specialized institutions to provide vocational education in agriculture and allied fields at the pre and post matriculate levels to cater the training needs of a large number of boys and girls coming from rural areas. Thus Krishi Vigyan Kendras (Agricultural Science Centres) were established as innovative institutions for imparting vocational training to the practicing farmers, school dropouts and field level extension functionaries. During each plan period, performance of KVKs was reviewed and more and more KVKs were established in the country successively. On the occasion of the independence Day Speech on 15th August, 2005, the Hon'ble Prime Minister of India announced that by the end of 2007 there should be one KVK in each of the rural districts of the country. Subsequently there are 634 KVKs established in the country till date. The mandates of KVKs are:

(1) Organizing frontline demonstrations (FLD) to establish production potential of various crops and enterprises on the farmers fields, (2) Conducting on-farm testing (OFT) to identify the location specificity of agricultural technologies under various farming systems, (3) Organizing need based training of farmers to update their knowledge and skills in modern agricultural technologies related to technology assessment, refinement and demonstration, and training of extension personnel to orient them in the frontier areas of technology development, (4) Creating awareness about improved technologies to larger masses through appropriate extension programmes, (5) Production and supply of good quality seeds and planting materials, livestock, poultry and fisheries breeds and products and various bio-products to the farming community and (6) work as resource and knowledge

centre of agricultural technology for supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district.

Though the concept of KVK was initiated as a training and extension organization, present mandates indicate that **KVK is not merely an extension organization**. It should be clearly understood that technology transfer is not a primary function of KVKs whereas Technology transfer is the responsibility of State departments. The KVKs on the other hand will assess and refine (if needed) the newly released technologies, demonstrate the proven ones and train farmers and extension functionaries on the same. The KVK technology demonstrations are called Frontline as it happens for the first time in an area, whereas field departments conduct field demonstrations on large scale.

Fisheries Extension

Fisheries Extension brings to the fishermen, fish farmers, and fish processors that form of educational assistance best suited to their needs. A more detailed definition of fisheries extension is: a system which assists people in the fish and fishing industry, through educational procedures, in improving fishing, fish farming and fish processing methods, increasing production efficiency and income, and improving their socio-economic conditions.

KVK (Ernakulam) of CMFRI

Krishi Vigyan Kendra (Ernakulam) is the oldest KVK in Kerala and one among the 12 second oldest in the country. This KVK started functioning in 1976 after 2 years of commencement of first KVK in the country at Pondichery. KVK (Ernakulam) since its inception was under the administrative control of Central Marine Fisheries Research Institute. Hence this KVK worked mostly on the popularization of fisheries technologies and trained number of fishermen from all the maritime states. Its location at Narakkal village in Vypene island also facilitated fisheries and aquaculture as its centre of activities. However in recent times, the mandates of KVKs expanded and presently KVK aims at the overall development of the district in agriculture and allied sectors. The Kendra has linkages with all the line departments in the district in addition to contacts with most of the Agricultural Universities and all the ICAR Institutes in the country. Since inception this KVK has organized more than 670 training programmes having duration of 1 to 30 days, covering more than 13,000 villagers including farmers, fishermen, farm labours and rural youth including women. The Trainers' Training Centre has organized around 150 training programmes on different topics related to coastal aquaculture for service extension personnel/entrepreneurs from all over the maritime states. This KVK has played a key role in standardizing the shrimp farming and popularizing it all along the coastal areas of the country.

Major contributions of this KVK in the field of Fisheries and Aquaculture

1. Introduced and popularized intensive shrimp farming in coastal areas in the country.

KVK with the technical support of Central Institute for Brackish Water Aquaculture (CIBA) and CMFRI introduced and popularized intensive farming of *P. monodon* in coastal areas wherein traditional farming had been carrying out. All Scientific shrimp farming created a revolution in the brackish water aquaculture sector. As a result of the successful demonstrations, agencies like ADAK, BFFDA, etc., formulated several schemes for the scale up of the programme for the benefit of the fish farmers.

2. Popularized the Mud crab farming and fattening in Kerala

Mud crab, *Scylla serrate* is a good candidate species for brackish water aquaculture. KVK took initiative to demonstrate the Mud crab, *Scylla serrate* in abandoned brackish water bodies using supplementary feeds. The programme received good response among farmers. Kerala fisheries department has taken up the programme and included in the fisheries development programmes of the state. Presently, district fish farmer's development agency of Kerala fisheries Department provide subsidies for mud crab farming through "Malsya Samridhi" programme.

Mud crabs of genus *Scylla*, also known as green crabs or mangroove crabs constitute an important secondary crop in the traditional prawn or fish culture systems in the Asian countries. Crab fattening is essentially a holding operation during which post-moult or water crabs are kept for a short period of 20 days until they 'flesh out' or immature female crabs are held until their gonads develop and fill the mantle cavity. It has high demand and price in the export market. KVK demonstrated fattening of Mud crab, *Scylla serrate* in open as well as cage systems. Low value water crabs procured from the market and caught from wild were used for fattening process. Thereafter, many brackish water fish farmers initiated the fattening programme in the state.

3. Introduced and demonstrated Asian Seabass farming in Kerala

Asian seabass (or barramundi), *Lates calcarifer*, is a large predatory fish found in coastal, estuarine and freshwater environments in the Indo-Pacific region. It is traded in plate size (300 – 500g whole) and as a fillet or large whole fish (approximately 2kg). Seabass flesh has a reputation of having premium edible properties as it is tender, white, firm, mild tasting with boneless fillets. Asian seabass is a fast growing species making it a popular species for aquaculture.

Techniques for its culture were first developed in Thailand in the early 1970s. During the 80s and 90s, seabass aquaculture expanded to China, India, Indonesia, Malaysia, the Philippines, Singapore, Taiwan, Vietnam and Australia. More recently, countries such as the USA, the Netherlands, the UK and Israel have embraced seabass farming with supporting active research into improving culture techniques. KVK demonstrated pond farming of Asian Seabass (*Lates calcarifer*) in Ernakulam district. Nursery reared fingerlings

were used for the demonstration. The programme got impressive attention among the farmers. Many farmers initiated Asian Seabass culture in ponds as well as cages in the district.

4. Popularized Green Mussel farming in open water as a group venture in Kerala

The mussels are bivalve molluscs typically inhabiting the littoral to shallow sublittoral zones of the coastal areas. The soft tissue of bivalves is enclosed in a shell consisting of two valves joined at one edge by a flexible ligament called the hinge. Mussels are found attached to the hard surfaces in the littoral and sublittoral zones by secreting long fine silky threads called byssus threads. Being sedentary, they can tolerate short periods of exposure to extreme temperatures, salinities, desiccation and relatively high levels of turbidity. The two species of mussels with good potential for culture in India are the green mussel, *Perna viridis* and the brown mussel *Perna indica*. KVK demonstrated farming of Green Mussel (*Perna viridis*) in back waters of the district. Rack culture using locally available bamboo poles was good successful model for the district. Women and Men SHG groups were associated in the programme.

Recent success stories of KVK (Ernakulam) of CMFRI in fisheries and Aquaculture

1. Transformation of a traditional fish farmer into a successful Aquapreneur

Mr Ambrose Thommassery is a 61-year-old traditional fisherman hailing from Kumbalangi in Kochi. Kumbalangi is known for its scenic beauty of backwaters, which attracts many tourists. There are a number of brackish water ponds in this area, one of which is owned by Ambrose. It's a 0.8 acre pond having water exchange naturally due to tidal fluctuations. Traditional prawn culture existed in the area during 1980's and farmers turned to intensive culture during 1st half of the 1990's. Later on, with the incidence of White Spot Syndrome Viral (WSSV) attack, the glory of prawn farming started receding. This left a large number of productive brackish water ponds (16,213 ha) in and around Kochi barren (5126 ha). Some traditional farmers like Ambrose who did not have any other livelihood option opted for traditional prawn filtration, wherein the prawn larvae which enters the field during high tide gets trapped. It is then allowed to grow there without any external feed. This process takes up to 6 months and Ambrose gets a profit of Rs. 10,000 from the 0.8 acre pond. In addition, he goes for fishing using traditional gears to sustain his family of four.

Mullet (*Mugil cephalus*) called Thirutha in Malayalam is a delicious brackish water fish popular in Kerala. The native mullet price varies from Rs. 350 -500 per kilogram. There are traditional mullet farms in Kochi, whereas the survival percentage would be as low as 10-30 per cent due to lack of scientific care in the initial stages. The greatest difficulty in its farming is getting of the seeds. Hatchery method of seed production is not yet successful and hence only option is to collect seeds from wild. There are traditional fishermen experienced in catching seedlings from wild.

KVK demonstrated scientific mullet farming at Mr. Ambrose's farm. The whole pond was de-watered, the weed fishes were removed and the complete drying of the pond ensured for 3 days. Lime was applied @2 kg/cent for sterilization and to induce algal blooming. The pond was then filled with water by allowing natural in flow. It was then kept undisturbed for 7 days to ensure algal blooming. Quality control of seeds by ensuring healthy and damage free seeds collected from wild using cast net and its transportation in oxygen filled packets were ensured. 4ft×4ft× 4ft Happa nets made of velon screen with bird repellent nets were erected in the pond using bamboo poles. In order to ensure proper water exchange and removal of faecal matter and feed waste, happa bottom was kept at a height of 1 feet from the pond bottom. Total of 6 happas were installed at a distance of 2 ft. The mullet seeds of 0.8 to 1.5 cm length and 150 to 250 mg weight were stocked at a density of 250 Nos. per happa amounting 1500 in total. In order to compensate the transportation stress, 30 minute acclimatization time was given for the seeds before they were deposited in the cages. Spot feeding with 500 micron size slow-sinking formulated pellet feed with 55 per cent protein and 12 per cent fat was started after 8 hours. This feed continued for 10 days @ 5 times a day. 700 micron size pellet feed having same protein and fat content was administered for further 30 days. This feeding pattern was then changed successively to 1 mm formulated feed having 48 per cent protein and 8 per cent fat for another 10 days. The feeding interval reduced to 3 times a day. During this process, happa nets were washed once in 7 days to ensure proper water exchange. With this 50 day intensive care, all the seeds reached average of 7 cm length and 6 gm weight. The survival percentage during this intensive care period was 90.

The seeds were then released into the pond for grow-out culture. The feeding interval was reduced to 2 times a day with the same feed for another 1 month. Further the fishes were weaned to 2 mm floating pellet feed with 35 per cent protein and 6 per cent fat. The tidal fluctuations were harnessed to the fullest extent to ensure proper water exchange in the pond. In addition, pumping also was done during low natural exchange. Once the fishes reached 250 gms, weaning was done to 3 mm feed having 28 per cent protein and 5 per cent fat and feeding further reduced to 2 times a day. The culture continued for further 10 months. The fishes reached average length of 35 cm and weight of 520 gms. Final survival percentage was 80.

The whole planning was done in such a way that the fish can be harvested on the next day of Onam - a famous festival in Kerala, when this fish gets maximum price. Since it was festive season, the marketing strategy was formed in such a way that the fish was sold live from the farm, avoiding intermediaries. The total expenditure including seed cost, feed, pond cleaning and other miscellaneous expenditure was Rs 44,500. A total of 500 kg fish was harvested and sold @ 500/- per kilogramme fetching a total income of Rs 2.5 lakhs. Ambrose and his friends learned the technique of farming and marketing. A group of farmers are getting ready for scientific mullet farming for next season at Kumbalangi by raising their own funds. Ambrose has already kept Rs 50,000/- as bank fixed deposit as an investment for the next season. KVK also got encouragement to replicate similar models elsewhere in the coastal regions of Ernakulam District, where many brackish water bodies are lying unutilized.

2. Paddy-shrimp-fin fish integrated culture in Pokkali fields to rejuvenate the farming system.

Pokkali farming is a typical farming system in which paddy and shrimp cultures are alternatively done in the same field. The biomass residues of the paddy crop forms the feed for the shrimps and the residues of the shrimp culture forms the fertiliser for the paddy. The Pokkali fields are spread in about 5000 ha area in Ernakulam, Alappuzha, parts of Kottayam and Thrissur districts of Kerala. The paddy culture is generally done during June to October (120 days maturity period) followed by shrimp farming during November to April. The Pokkali farming is purely organic and the paddy and prawn possess good taste since there is no chemical inputs are used. During the year 2009, Pokkali farming system received Geographical Indication (GI) certificate and an approved logo for its products. The pokkali farming community also received Plant Genome Community saviour Award during 2010-2011.

Typical Pokkali fields would have an area ranging from 2 to 30 acres. Each pokkali field is confined within bunds. There will be one sluice gate for water movement to and from the field. The area inside the field adjacent to the sluice gate is called *Sluice pit (Thoombukuzhi)* which accounts to an area of 5% of total area of the field. This has an average depth of 2 to 3 m. There will be a main drainage channel having approximately 4 to 6 m width and 1 to 3m depth orienting along the major dimension of the field and spreading upstream from the sluice pit. There will be many sub channels draining water from the other parts of the field to the main drainage. These sub channels may be of shallow depth. Paddy would be planted in the field as well as in these sub channels. It is important to note that the sluice pit and the main channel will be filled with water at all phases of pokkali cultivation and is suitable for fish culture.

Since Pokkali farming is climate dependent, constant attention is required at each phase of the paddy/shrimp cultivation. Even then, the production is unpredictable. Large amount of labour is required for pokkali land preparation, bund forming, planting, harvesting, transportation, whereas no specialized equipment or machinery is available for pokkali fields to replace human labour. Labour in Kerala is scarce and costly. The pollution from the nearby industries also contaminating the pokkali fields. Quality and taste of the pokkali paddy are its attractions, whereas there is no premium market for the pokkali paddy products. Hence area under paddy farming in pokkali system is getting declined. The loss in paddy is generally compensated by shrimp farming, whereas due to the widespread attack of White spot syndrome (WSS) viral infection to the shrimps, this farming also turned unprofitable. Due to these reasons, most of the pokkali lands turn in to barren.

In this circumstance only the KVK (Ernakulam) of CMFRI suggested a new method of integrating cage culture of fin fish with Pokkali farming system. The un-utilized sluice pit and channels in Pokkali fields can be utilized for this purpose and hence this new method would in no way disturb the traditional Pokkali farming system. Mr. Saibil a young farmer from Ezhikkara readily agreed for this new experiment in his Pokkali field, which is funded by the National Initiative on Climate Resilient Agriculture (NICRA). The KVK team trained him in Pond preparation, cat walk construction, cage construction, nursery rearing, fish

transportation, feeding, cage maintenance, etc., in well advance to the implementation of the programme. The sluice pits and channels were de-silted and cleaned to ensure minimum 2m water depth in the site. Catwalks were constructed in the field to facilitate feeding and other management works in happas and cages. Happas of different dimensions (4mm, 6mm) were fabricated depending on the depth of the field. Small cages (2m X 2m X 1.3m) were fabricated using HDPE nets having different dimensions and thickness for the grow-out culture of target fishes. These small cages were placed in the field using PVC material as floats, sinkers and top cover. 90mm PVC pipes were used for fabricating the floats, 32mm sand filled PVC were used for making sinkers and 40mm PVC with HDPE nets were used for fabricating the top cover.

Nursery reared Mullet (*Mugil cephalus*) and Pearlsport (*Etroplus Suratensis*) were stocked in cages during 1st week of September. The initial stocking density of mullet was 250 nos. per cage and that of Pearlsport was 500 nos. per cage. They were fed using floating formulated pellet feeds of different size (2mm,3mm,4mm) during dawn and dusk. Cages were cleaned fortnightly and nets were changed once in two months period. Thinning out was done depending on the growth rate. The culture continued for 8 months. The mullet attained average size of 400 gm with survival of 60 per cent and Pearlsport 180 gm with a survival of 90 per cent.

The fixed cost required for the cage culture in 1 ha pokkali fields is INR88,200/-. Since the assets can be used for 5 years, the fixed cost per year would be INR17,640/-. The operational cost per year is INR90,000/-. The gross income per year would be INR1,90,000/- and the profit per year would be INR83,000/-. The present profit from paddy alone is only INR 15,000/- and that from paddy-shrimp field is INR50,000/-. In order to revive pokkali farming, this new method which fetch the farmer additional income of INR83000/- per ha need to be promoted. The initial investment can be provided on loan to the farmers through financial institutions. KVK and CMFRI can provide technical assistance to the farmers.

3. Introduced and popularized small scale cage farming in Kerala

Inland fishery resources in the eastern parts of the Ernakulam district which falls under the Western Ghats region are getting depleted day by day due to severe reclamation of water resources, quarry operations and lack of strategic interventions by the research and development agencies. The foothill regions of the Western Ghats region, lying in the Ernakulam district area, holds 776 large granite quarries which include both abandoned and functioning ones. The abandoned quarries are ideal places for aquaculture ventures though no strategic approach has been developed to utilize the large volume of potential fresh water resource which can contribute to fish enhancement and livelihood security in the region. To optimally utilize these abandoned resources for large scale fish production, a model was developed and implemented in Kothamangalam area with the participation of inland fish farmers. Kothamangalam, known as the Gateway of high range region, possesses 96 granite quarries of which most of them are abandoned. A cage aquaculture model was initiated since harvesting, predation and feeding are the main problems for doing any aquaculture activity in granite quarries due to its depth. A granite quarry of 50 cent area was selected as the site for implementing the programme. The selected quarry has 15m water depth and year round water availability. Small floating cages were fabricated and

erected in the granite quarry for the high density culture programme. High value fish species such as Pearl spot (*Etroplus suratensis*) and fast growing Tilapia (*Tilapia nilotica*) were selected as candidate species. From the action research programme it is clear that the high density fish culture programme is the one of the best methodology for fish stock enhancement as well as to ensure livelihood security of the inland community of the district. Now more farmers in the district are attracted by the initiative and have started to use their own quarries for fish culture ventures. If the programme is visualized in a broader ecological and commercial perspective, optimum utilization of abandoned aquatic commons in future will get more momentum in the country.

4. KVK supply Pearls spot seeds and popularized farming

Pearl spot (*Etroplus suratensis*), popularly called as Karimeen is an indigenous fish extensively found along the east and south-west coasts of Peninsular India. Pearl spot is the one of the prime high value euryhaline candidate fish species presently using for brackish water and fresh water fish farming ventures in Kerala. Recently Kerala government has declared Pearl spot as “State Fish of Kerala” and the state has celebrated the year 2010-2011 as the “The Year of Karimeen” for creating awareness about the conservation need and commercial production potential in Kerala. The present annual production of 2,000 MT is found to be insufficient to meet the ever increasing demands for “Kerala Karimeen” in the country, whereas the price of this fish ranges from Rs.250-350/- per kilogram in the domestic market. It is estimated that annual production of 10,000 MT would be required to meet the present requirement. This situation mobilized the farmers to initiate Pearl spot culture using wild caught seeds in different parts of the state.

At present the seeds (fry's/fingerlings) required for the culture in backyard ponds, tanks, artisanal cages etc. are collected from the wild. Over exploitation of indigenous Pearl spot seeds from wild resulted in the depletion of standing stock in recent times. Hence there is enormous potential for the production and supply of this seed. Institutions having skill and experience in imparting training on the Pearl spot production technology is less in the State. It is estimated that per year requirement of Pearl spot seeds in Kerala is as high as 40 million, whereas the present availability is only 8 million. Low fecundity and parental care of this fish are the major constraints in its large scale seed production.

Krishi Vigyan Kendra (Ernakulam) maintain a brood stock at its campus at Narakkal, which contains approximately 2000 pairs of Pearl spot fish which is one of the largest collections in the country. This stock has potential in producing 1.2 million seeds per year. Method of egg collection and seed production in hatchery conditions were standardized. This KVK has standardized two methods for seed production. One is accelerated seed production in the ponds where in favorable environment is created for the fish to egg and rear the larvae. This is done by ensuring water quality, selective removal of weed fish and providing egg depositing surfaces in ponds. Second method involves extended hatchery technique wherein the egg deposits are carefully transferred to a tank and parental aeration is simulated using a blower. The water quality and salinity are precisely adjusted. The hatched out larvae are fed using *Artemia* nauplii till 3 days and

thereafter formulated pellet feed. In addition, pilot scale farming of Pearl spot in cages were also initiated by this KVK.

In order to further increase the seed production, KVK started satellite seed production centers at farmers fields also.

5. Fresh water carp seed production in Public-Private-Partnership mode

Fresh water Aquaculture is getting a good momentum in the country due to the ever increasing demand for fish as essential protein source. Among the different categories of fresh water fishes being used for culture, carps stood in the prime position. Requirement of carp seeds for the farming in Kerala is presently met from the nearby states especially from Andrapradesh. It is estimated that 40 million carp seeds are being sourced by the different private retailers and hatchery persons in Kerala. In this backdrop, Ernakulam Krishi Vigyan Kendra established a “Portable Chinese Carp Hatchery” unit at Kothamangalam farmer field. This model was developed by Central Institute of Freshwater Aquaculture (CIFA), Kausalyanga, Bhubaneswar-751002, Odisha. This facility can be used for fresh water fish seed production following the induced breeding technique. Seed production of all type of carp fishes such as Catla, Rohu, Mrigal, Koi carp, common carp, etc., can be carried out in such units. Total cost for the Portable type Carp hatchery is around INR 1 lakh. Portable Chinese Carp Hatchery is combinations of different type of specialized tanks such as brood stock holding tank, hatching tanks with water circulating and artificial showering facility.

As part of the front line demonstration programme of KVK one unit of Portable carp hatchery unit was installed during June 2012 in a farmers field near Kothamangalam. This location had several several small ponds with several types of carp brood fishes. First breeding trial was conducted using commercial grade synthetic hormone. Catla and Koi carp were used as candidate fish for breeding in the hatchery. One female two male combination were used for breeding. One pair produced 2 lakhs eggs. The eggs were transferred to hatching tanks for hatching. Freshly hatched fry's were collected stocked in freshly prepared nursery pond. The fry's were stocked in nursery ponds and reared sixty days and the fry's were become marketable size of INR 2.00. One batch breeding and nursery rearing work can earn generate INR 36,000. This whole process of breeding and hatching generally took less than ten days. Hence this unit can repeatedly use for multiple breeding and hatching purposes. Minimum five to seven times breeding can carry out using this unit during the post monsoon periods from June to September.

The farmer, Mr.Thakadiyel Joseph is selling the carp seeds in his trade name and also under the label of KVK.

6. KVK created successful entrepreneur on sea food production

KVK's comprehensive Entrepreneurship development programme conducted on *Production and marketing of fish products* was aimed at capacity building of rural youth in setting up of small scale sea food processing industries. Holistic approach including scientific practices, market study, production, labelling, branding, test marketing, knowledge on financial assistance, etc. help the trainees to start an enterprise of their own. As part of this training, KVK also facilitated trainees to obtain license from Food Safety and Standards Authority (FSSI). Such training programme during 2012-13 resulted in initiation

of a small scale fish processing unit by Mr Sujish Kumar at Narakkal. This industry is marketing fish pickle under the brand name *Malayalee foods*. With this success, KVK has converted all its trainings into Entrepreneurship development mode as mere training classes alone will not help to initiate an enterprise including farming.

7. KVK conducted National training on Recent advances in Aquaculture for popularization through KVKs

KVK conducted National training programme during 15th to 20th July 2013 at CMFRI, Kochi. The programme was inaugurated by Dr.V.Kripa, Director i/c on 15th July. Total 19 fisheries subject matter specialists from the states of Jammu and Kashmir, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Pondicherry, Goa, Kerala and Lakshadweep participated in the programme. Theory classes on modern tools in Fisheries/Aquaculture, Disease Management, Molluscan culture, Crustacean farming, Small scale high density fish culture, Fishery Post-harvest technologies, Marine and fresh water ornamental fisheries, Brackish water fin fish farming, Marine Sea cage culture, shrimp and prawn farming were covered in the training. The trainees visited Marine ornamental hatchery at CMFRI, Kochi. A practical session on Feed design and formulation was also covered.

The trainees were taken to Mandapam Regional Centre of CMFRI near Rameshwaram for two days. Practical sessions on live feed culture, hatchery management techniques, ornamental hatchery management, sea cage farming, brood stock development and induced spawning, disease management in hatchery and Re-circulatory aquaculture system was conducted. The trainees also visited sea weed culture farm and marine ornamental units maintained by farmers/entrepreneurs at Mandapam, Tamil Nadu.

All the trainees interacted with Dr.Syda Rao, Director, CMFRI on 20th July at CMFRI, Kochi. The training concluded with a validictory function and certificate distribution.

Conclusion:

Research organizations develop technologies for the masses and based on this, KVK develop location specific technology modules for a group of farmers. KVK demonstrate the technologies in farmer's fields to establish its production potential, which is further taken up in massive scale by the extension departments. There are new varieties of crops, new breeds of animals and fish released by the research organizations. These may not be available for the farmers in sufficient quantities. Here comes the role of KVKs using its own facility for seed production or through public-private partnership in satellite seed production/breeding units. Getting updates for farmers and development officials through training programmes refresh their knowledge and this important function is also being done by the KVKs. KVK is the knowledge and resource centre of all agricultural technologies in district level which is the only organization in the country where farmer get the services of all agricultural-animal husbandry-fisheries professionals under one umbrella.

Role and impact of a Business Incubator in promoting entrepreneurship and business development in Fisheries Sector

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Introduction

Business Incubation is a global paradigm aimed at the efficient use of business resources for nurturing business enterprise development. It is a well tested and essential development process for enabling innovation and entrepreneurship for start-up companies, and adding value to more established enterprises that need to change. In Indian agriculture, Fisheries sector occupies a very important place in the socio-economic development of the country and is a powerful income and employment generator, as it stimulates the growth of a number of subsidiary industries and is a source of cheap and nutritious food, besides being a foreign exchange earner. Despite its importance in industrialization and immense potential for employment generation, the entrepreneurs in this sector confront several problems in business development and management. Hence there is a great scope for a business incubator that can deliver an integrated package of business focused services under one roof and support technology based enterprises in fisheries sector.

Concept of business incubation

The concept of business incubation is exploding in popularity all over the world as a successful business model particularly in developing economies. They lower the entry barriers for young entrepreneurs to successfully start and scale their business by combining the features of technology commercialization, entrepreneurship and business facilitation. Business incubation has become a broad umbrella term referring to any organization that provides physical workspace, management and technical assistance, access to financing and other supporting services to young firms and helps them survive and grow during the start

up stage. With the increasing acceptability of business incubators, they are being widely used as a policy instrument in the process of industrialization through innovations, product development, and improvement in productivity. In the changing scenario, wherein technology is changing at a faster rate and product lifetime cycle is shrinking, technical entrepreneurship has assumed a central place for economic growth of a nation. A successful business incubator can create a good entrepreneurial environment and greatly improve a new enterprise's chance for success. In a country like India, where entrepreneurs and small scale companies contribute to industrial growth, business incubators have become an important source of help for start-up entrepreneurs.

Business Incubators are attractive and have grown in numbers because of the start up business growth rate through the direct support structure for fragile enterprises. Their attraction is based on jobs creation with low public cost and the array of services offered by the incubation management to support the incubatee. This assistance can take the form of flexible lease terms for space, shared services in office support, on-site business assistance, opportunities for tenant networking, and resource matching. The incubators flexibility in terms of the types of benefits and services offered to entrepreneurs accommodates several types of growth of economic development. A business incubator provides the transformation of their ideas into start up business or viable business ventures. In addition, the Entrepreneur companies receive support and guidance to market their business concepts, work effectively to reduce the failures and ability of free standing in the market after graduation from the incubation program.

Advantages of business incubation facility

Small and medium scale enterprises are always attracted by the concept of business incubation due to its various advantages. Incubators incubate your early pre-product idea, help you make a prototype, and further make a product out of it through a longer period of engagement. For starters it helps to promote newbie ventures of young entrepreneurs, provides a wide range of entrepreneurship development initiatives such as training, nursery incubator space during the initial gestation period, central common machining facilities, systems and networking support, catalogue library, funding schemes among others. As a result of these facilities there is considerable reduction in the initial investment commitments of the entrepreneurs thereby reducing his risk quotient to a large extent. Other usual but useful facilities such as workshops, computer networks with internet facilities etc., have proven to be a boon for upcoming enterprises. The instant availability of common facilities for new ventures motivate the entrepreneurs to confidently set-up their own ventures and relieves them of start-up tensions thereby enabling them to focus their full attention on core competency development.

One of the many benefits from business incubators is that they speed up business development and quickly reduce uncertainty from the start. Business incubation provides a nurturing, instructive and supportive environment for entrepreneurs during the critical stages of starting up and growing a new business. The goal of business incubators is to increase the chance that a start-up will succeed and achieve growth and shorten the time and reduce the cost of establishing and growing its business. If successful, business

incubators can help to nurture the companies that will form the true creators of a region's or nation's future wealth and employment.

Entrepreneurship development through incubation

The need for entrepreneurship development

For many developing countries, micro and small scale enterprises account for the majority of the firms which fuels economic growth. Starting any business is fraught with uncertainty, financial burdens and resource issues, but more so with innovative and entrepreneurial businesses due to the complexity of the products and services being developed and, often, the length of time it takes to fully develop the product. Incubators are ideally placed to help innovators and entrepreneurs to overcome some of the hurdles and to negotiate a path to the all important finance and mentoring all entrepreneurs need. In supporting entrepreneurs with a one stop-style service, and reducing their over head costs by sharing facilities, business incubators are able to significantly improve the survival and growth prospects of new start-up companies.

Role of Incubators within the entrepreneurship ecosystem

Inventions with potentially high social and economic value can be found in numerous sources, including the grassroots, academia, small and large enterprises, R&D centres and government agencies. In today's global knowledge economy people and institutions also have immediate access to inventions that have already been introduced in other countries and settings. However the environment often discourages entrepreneurs from bringing inventions to market, regardless of the source. Many are not utilised because they are not adequately tailored to local needs. Thus, countries are faced with the challenge not only of spurring invention domestically or identifying existing inventions abroad that can be adapted to the local environment, but also of creating the conditions that allow the invention to be coupled with entrepreneurship, so that the economic and social wealth creation potential of the invention can be realised.

Business incubators have a unique position in the entrepreneurship ecosystem. They interact with all the actors in this ecosystem, either directly or indirectly, through the enterprises they serve, and feel first-hand the challenges that their clients face when seeking to set up and grow their enterprises whether the difficulties have to do with regulations, finance, labour or infrastructure. If these challenges are effectively communicated to the relevant actors in the ecosystem, a valuable feedback loop can be established which benefits not only the incubated enterprises, but innovative entrepreneurs across the economy.

Developing enterprises through business incubation

While an inexpensive building to house a new company's first business is a plus, it is not the main reason why new companies choose to enter a business incubator. The reasoning behind entering is mainly because of the services that are offered to these new companies by the business incubator. In any business incubator the ideal situation is that they are capable of providing client companies with business support services and resources that are tailored specifically to the individual firms. These services are generally developed by the management of the incubator. They can either be offered within the business

incubator's walls or outside the incubator through contact networks. Internally, there are two types of services that are offered: facilities and business services. When it comes to facility services, business incubators tend to offer rental space, flexible leases, shared equipment, shared basic business services, and technology support services.

A business incubator's offer of service tends to include management guidance, technical assistance, consulting that is geared towards the individual company, and aid in obtaining the finances needed for company growth. External services tend to depend on what types of internal services the particular business incubator offers. For example, if an incubator does not have a person on staff who is knowledgeable about filling out government grant forms, most incubators will know someone within their contact network to whom they can send a tenant company. As a result the tenant company can receive help even though the service is not offered internally. The costs for these services can vary depending on the agreement the particular business incubator has with that person/company. The majority of the time fees are reduced, but not free.

For a business incubator it is important and necessary to have the appropriate infrastructure in order to succeed. However, being able to offer services is just as, if not more important for the business incubator to be able to offer to their tenant companies than infrastructure. The reason for this is that entrepreneurs coming into the business incubator have a high chance of not having experience in the business world. As a result, they need to be able to have access to the tools and advice that is needed in order for them to succeed. Incubators have, as one of their common ingredients, the opportunity for new ventures to take shelter for, say, two years, from fierce competitive market forces that might otherwise destroy the infant enterprise before it gained size and strength sufficient to compete. This is inherent in the term 'incubator' itself, which is vividly metaphorical. The fundamental assumption here is one of market failure. Open competitive markets fail to provide conditions that allow many new start-ups to reach a viable size; hence there is need for intervention, in the form of an incubator. The very metaphor, "incubator" implies protecting prematurely born 'infants' from the harsh world, during the initial period.

Importance of ICT infrastructure for successful business incubation

For business incubators to function effectively, the governments within developing nations must overcome the numerous obstacles that can jeopardize the positive effectiveness within the incubation program. For developing countries to flourish in the global market, it is important that they invest their resources within its own population. Furthermore, education can also contribute in developing a country's Information and Communications Technology (ICT) infrastructure which successful business incubators are dependent on. However, many developing nations lack within this area thus creating a digital divide. The digital divide is the gap between those who have access to ICT and those who do not. Consequently, the digital divide harms developing nations from obtaining knowledge-based information that can benefit development and help them compete within the global markets. To close the digital divide gap, basic education is the imperative solution for poor countries to develop. Hence, technology itself will not solve the social discrepancies within these societies.

There requires highly-developed skills to access and interpret information, and without adequate education, it would be hard for an individual to fully understand the dual capabilities of a computer and the use of the internet. With a highly skilled population, nations can venture into research and development (R&D) to create new innovations and to improve the living conditions within their environment. Through R&D activities, it creates a demand for local engineers and scientists who better understand the issues affecting the region. As a result, developing countries such as India have built strong technological capabilities within the IT sector.

Business incubation initiative by ICAR

The Indian Council of Agricultural Research (ICAR) with the help of World Bank funded National Agricultural Innovation Project (NAIP), has started a business incubation drive designed for the Indian agricultural sector to promote agribusiness by utilizing the vast research and development facilities and knowledge available with its research institutions. This initiative is directed to facilitate innovative involvement of all the players and stakeholders in the production and distribution of its goods and services for attaining sustainable food and livelihoods security as well as for global competitiveness of Indian agriculture. With the aim of translating the research results arising from the field of fisheries and other agricultural sectors, ICAR has set up a unique Business Incubation Centre (BIC) under the project Zonal Technology Management – Business Planning and Development (ZTM-BPD) Unit at Central Institute of Fisheries Technology, Cochin, Kerala.

Role of business incubation centre at CIFT, Cochin

Fisheries sector with its important role played in the socio-economic development of the country has become a powerful income and employment generator, and stimulates the growth of a number of subsidiary small, medium and large scale industries. BIC at CIFT, managed by ZTM-BPD Unit, aims at establishment of fisheries enterprises through IPR enabled ICAR technologies. BIC supports operations on business projects as a measure of enhancing the foundation for new technology based industries and establishing a knowledge-based economy. It focuses on finding new ways of doing business in fisheries and allied agricultural fields by finding doors to unexplored markets. The Centre helps prospective entrepreneurs, by providing pro-active and value-added business support in terms of technical consultancy, infrastructure facility, experts' guidance and training to develop technology based business ideas and establish sustainable enterprises. It acts as a platform for the speedy commercialization of the ICAR technologies, through an interfacing and networking mechanism between research institutions, industries and financial institutions.

The Incubator at CIFT differs from traditional Business Incubators as it is tailored specifically for technology based industries and is operational at an area with a high concentration of fish production. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. BIC offers their services to industries not only in Cochin, but also all over India through virtual incubation. Beyond promoting business growth, the Centre is also trying to bring its benefits to all the fisheries communities in India. With the aim of transforming the incubator into a symbol of entrepreneurship and innovation, the ZTM-BPD Unit has created an environment for providing timely scientific and technical assistance and support required for establishment

of technology based business ventures. The activities of the ZTM-BPD Unit focuses on finding creative and innovative ways for linking public sector resources and private sector initiatives within and across regional and national boundaries for promoting economic growth. The Centre uses the right expertise in relevant fields to identify and analyze the constraints and barriers hindering the growth of a business and devise appropriate strategies. It explores various structures and strategies to help small enterprises to grow and ensure a promising future in the global market. It fosters corporate and community collaborative efforts, while nurturing positive government-research-business relationships. Business Incubation programme at CIFT is selective. It is aimed at assisting growth oriented entrepreneurs in their quest to grow and to become more competitive. Only a subset of entrepreneurs is growth oriented and pursuing an innovative venture. A critical mass of potential business incubation applicants is therefore necessary for business incubation to be an efficient tool for fostering innovative entrepreneurship.

Catering to the needs of entrepreneurs

The Centre regularly conducts industry interface and technology promotional programmes for sensitization of entrepreneurs and to identify interested potential candidates for physical and virtual incubation. The Clients at BIC gets the privilege of meeting Scientists, Business Manager and Business Associates directly, to discuss and finalise the strategies to be adopted to take the business forward. It is also the peer-to-peer relationships that develop within the incubator, that ensures the delivery of basic services such as how to actually incorporate a business; what are the legal issues; how to take intellectual property protection; how to do basic accounting and cash flow; how to do business presentations etc. Those kinds of skills are what are transmitted as part of the incubation process.

The business oriented services offered by BIC include assistance in complying with business regulations, licensing procedures, financing, information services, marketing and tailor-made services designed for the various tenant enterprises. Incubator clients can also gain special advantage in terms of tax savings through special regulations for Business Incubators. BIC also offers a wide variety of services, with the help of strong associations throughout the Business Incubation Network.

The ZTM-BPD Unit facilitates the availability of loans with the aid of State Bank of India (SBI), Agri-Commercial Wing and provides direct access to financial schemes offered by Micro Small and Medium Enterprises (MSME) for gathering capital investment, company expansion and new product development. It also helps entrepreneurs in developing linkages with various venture funding agencies. BIC being a registered member of Indian STEP and Business Incubators Association (ISBA), the privileged tenants of incubator are entitled for getting tax exemption benefits as well as opportunity to attend the ISBA Annual conference, workshops, training programs etc.

The ZTM-BPD Units conducts Workshops, Meetings and Seminars for awareness creation, faster adoption and implementation of the new scheme of Intellectual Property Management and Technology Transfer/Commercialization within ICAR. This has helped in chalking out the best-fit strategies and work plan for IP management by inculcating business ethos in transfer of both proprietary and public domain technologies. The scientific community was trained in handling technical information, finding solutions to technical

problems, acquiring rights in public domain, identifying patentability potential of technologies at early stages of development, avoiding risk of R&D duplication and solving potential disputes involving patents. The incubatees were given clear guidelines to convert their innovative ideas into business activities, to evaluate the commercial and economic viability of an invention, to formulate business plans and R&D contracts, to market and commercialize the invention, and to find potential business partners. Disputable areas regarding ownership of patents, acquiring trademarks in the name of the institutes, acknowledging the parent institution while selling the technologies etc. were sorted out during such meetings.

Human resource development for the fisheries industry has been in the mandate of

CIFT since its inception. Fish processing industry is a fast growing industry in our country as well as abroad, where there are immense opportunities for rightly trained professionals. CIFT has the right expertise and facilities to provide hands-on, application-based training courses such as HACCP concepts, HACCP Audit, Seafood Quality Assurance, Basic Food Hygiene, Food Processing and Preservation, Energy Efficient Harvesting Techniques, Boat Construction etc. Successful trainees have high potential for employment in India and various foreign countries including Middle East and South Africa. The ZTM-BPD Unit organises several awareness workshops, seminars, training programmes etc. for human resource development in the fisheries sector. The Unit also conducts capacity building programmes to help the incubatees build their competence in the areas of business practices, technology up scaling, networking and financing strategies.

Conclusion

It is evident that business incubator programs can have a significant effect in bringing economic growth to the developing world. Amidst the changing paradigms and demanding global structure, India, in order to remain a frontrunner among developing nations, has primarily focused on the fisheries sector. In this context, business incubators which can help entrepreneurs turn their ideas into viable businesses and promote innovation, by providing business support services and resources have great scope and significance. From the experience of BIC at CIFT, by assisting small businesses to mature, they were able to create jobs and generate fresh capital. With a combination of effective policies, ethical governments, and business incentives, many developing countries can compete within the global economy and receive foreign private investments rather than foreign aid. As a result, the business population can experience an improvement in their quality of life due to the opportunities created by business incubators.

Economics, fisheries and responsible fisheries management

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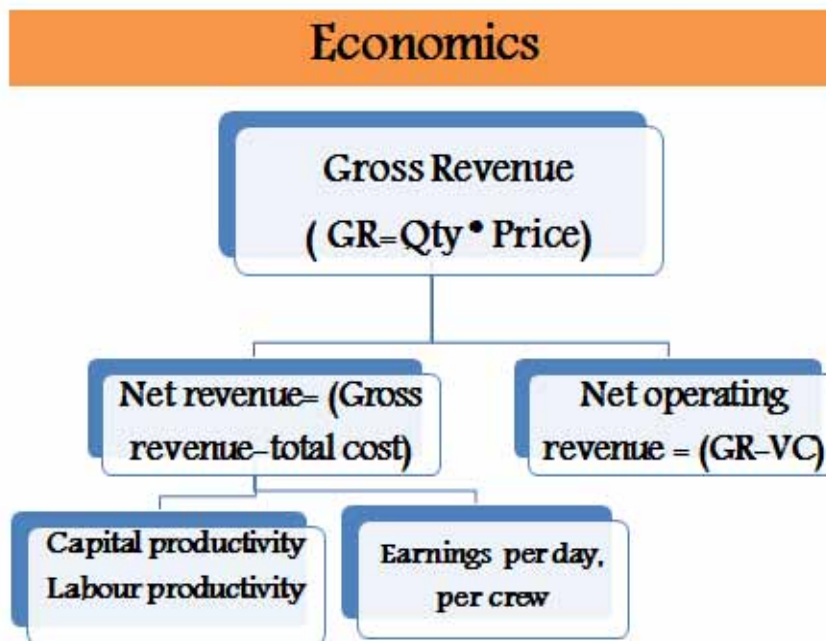
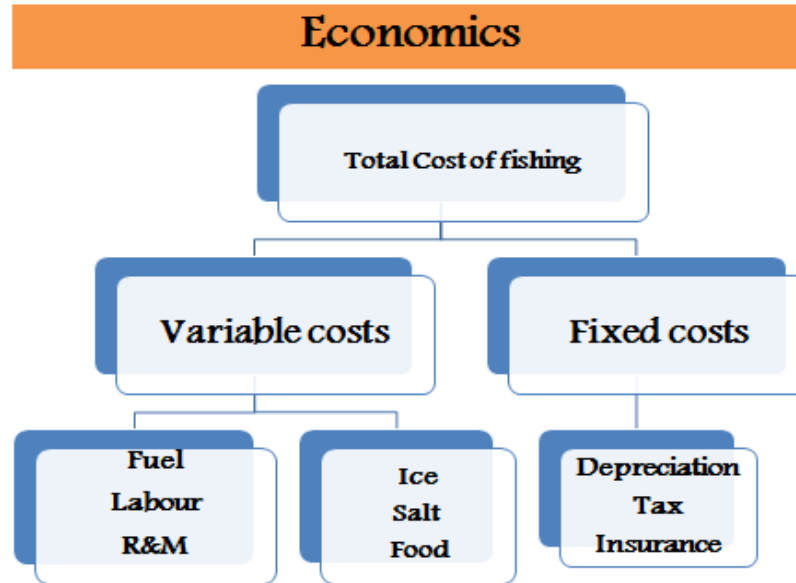
Introduction

Economics is the basis for life. Every one of us is a practicing economist in himself/herself in life. The principle of economics, when applied to fields like agriculture, animal husbandry, fisheries, poultry and other enterprises becomes more valuable. Initially fisheries did not consider economics as a component. But later in course of time, the fishery biologists realized that economics is a vital component of fisheries management. In this lecture we will see the concepts of economics, fisheries and responsible management separately and finally link them for a better understanding.

Economics: A few basic concepts

Wants are unlimited but the means to satisfy them are limited. This is the basis of scarcity definition of Economics. In the wider sense, the resources at our disposal to meet our requirements are limited. We have to allocate the resources among the competing alternatives, for which the economic theory helps us. Optimization of resource use to obtain maximum profit is one of the aims for applying economic principle in entrepreneurship.

In fisheries also, the economic principles are allocated for formulating fisheries management measures. In fisheries, the point of optimum harvest occurs where the average revenue cost cuts the average revenue curve, contrary to the other fields, where the optimum occurs where marginal cost cuts the marginal revenue curve.



Fishery resources

Fishery resources are renewable natural resource but are not inexhaustible extinct if the rate of harvest or exploitation is higher than the rate of regeneration or reproduction. Here the

size of the stock (population) depends on the biological, economic and social considerations. Fisheries come under Common Property Resource (CPR), due to which a comprehensive management measure could not be exercised. “In an open access regime like fishery, negative externalities are many, which implies that uncontrolled fishery will bound to end up in what is called tragedy of commons.” (Grafton *et.al*, 2006)

Sustainable Fisheries Yield

The sustainable yield in fishing commonly referred to as “Maximum Sustainable Yield (MSY) is a biological phenomenon. MSY means that level of fish catch or yield that can be harvested from a given system in perpetuity without affecting the stock of the system (or the sea). In other words, a catch level is said to be sustainable whenever it equals the growth rate of the population since it can be maintained for ever. As long as the population size remains constant, the growth rate will remain constant as well.

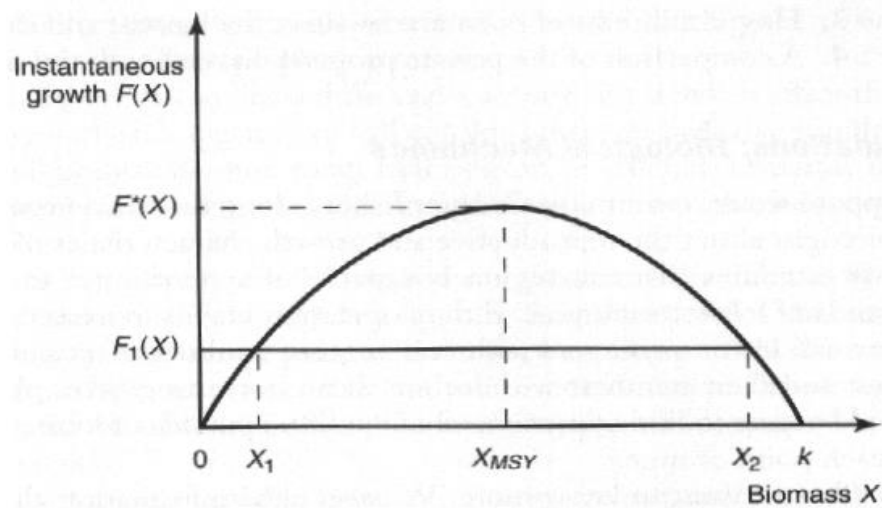


Figure: Sustainable Yield Curve

Economics of fisheries management

Economics play a vital role in fisheries management. In the earlier stages, fisheries management focused on controlling the effort to maintain the fish stocks. The common assumption is that if the control measures are strictly implemented, the further increase in effort is prevented and thus a sustainable harvest can be expected. But by 1970 it was found that such measures fail to control the fishing effort and capacity as the fishers substituted from regulated to unregulated inputs (Wilén, 1979) and further remedies suggested also failed to prevent the increase in fishing effort (Townsend, 1990).

“An economic perspective of fisheries management is that marine resources should not only be managed sustainably but also in a way that they contribute to and provide net

benefits for the nation as a whole. Indeed the economists argue that sustainable and economically profitable fishery is complimentary. A level of harvest that maximizes the sustainable returns from fishing is often at a stock size that is greater than that which would maximize the overall yield from a fishery. Moreover, if there are other costs associated with fishing like habitat damage or environment loss etc., the economic optimum level of harvest that accounts for these costs would be even less, and the desirable fish stock even larger. In other words, a fishery that is economically optimum in the long run is also likely to be an ecologically sustainable fishery". (Grafton, et al., 2006)

Maximum Economic Yield (MEY) is realized at that level of effort in which the sustainable net return from the fishery is maximum. The difference between the total revenue (TR) and the total cost (TC) is maximum. This difference is also referred to as **resource rent**.

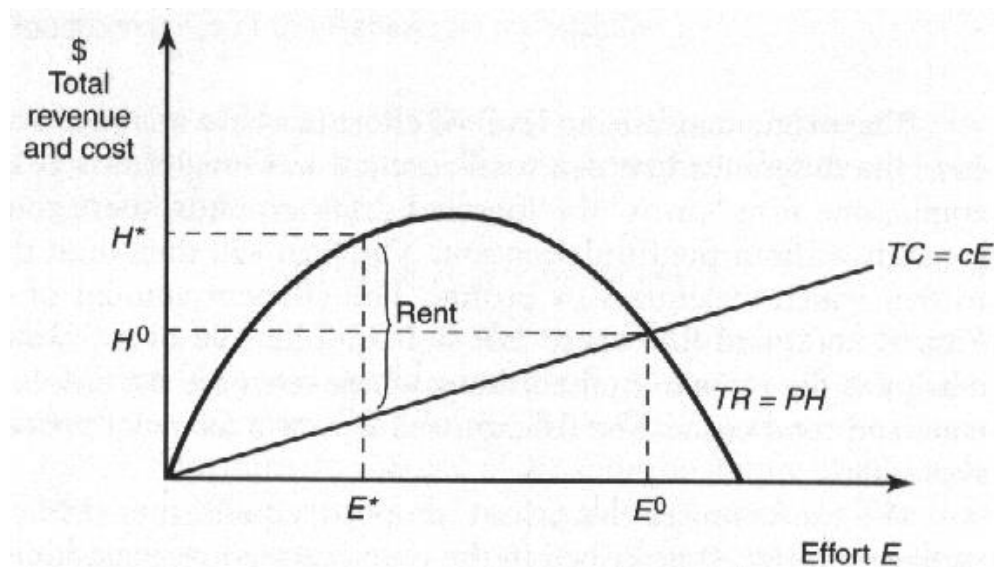


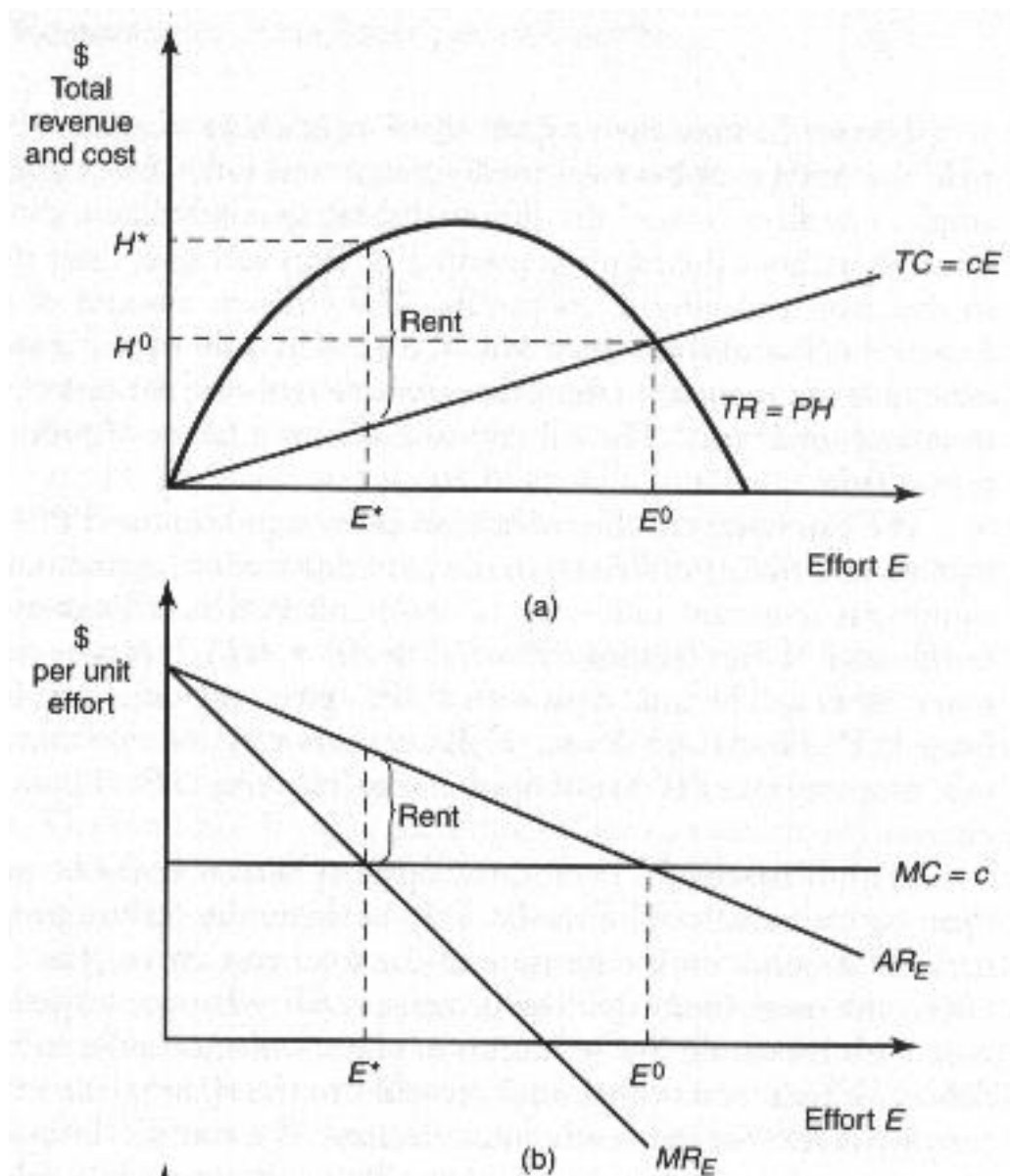
Figure Maximum Economic Yield

- Total revenue (TR) = Price (P) \times Catch (H)
- TC = Unit cost (c) \times Effort
- $Rent = TR - TC$

The resource rent is maximized at the point E^* . Here MEY is left of MSY

- Optimal harvest (H^*) is less than the MSY harvest
- But rent is larger than at MSY

The marginal analysis can show that the MEY occurs at the point where $MC = MR$. It is observed that for marginal unit of effort, marginal rent is $= 0$ and average rent > 1 .



The point E^* is that effort level at which the MEY occurs. At this point of effort only the **difference between the total revenue from fishing and total cost of fishing is the maximum**. This difference is also referred to as **resource rent**.

“Goal of traditional fisheries management: achieve *MSY*. However the economists aim for MEY in contrast to *MSY*. AT MEY, compared to *MSY*, the fish catch is lower, fishing profit is higher, fishing effort is lower and the fish stock is higher. Thus MEY is where more fish is conserved.(Dixon, 2005 and Grafton et.al., 2006)

MEY is affected by the changes in price of fish and the costs of fishing. When the price of fish increases, the total revenue curve shifts upward at all effort levels, leaving the intercepts unchanged and the point of MEY moves closer to MSY but never beyond MSY so long as the cost of fishing increases with effort. On the other hand, if the cost of fishing increases, the total cost curve moves upward to the left, thus the new point of MEY is to the left of the previous MEY. This will lower the optimal fishing effort (E^*) because with a more costly harvest, it pays more to have larger stocks from which to catch. In total, a fall in fish price or an increase in cost of fishing will lead to lower harvest with a less fishing effort and a larger stock size in order to maximize the economic profits (Grafton et.al., 2006)

Fishery regulation

Fisheries are open access resource or common property resource where every one has , equal right to fish. In such cases there is no monitoring of the level of harvest by the individual fishing sector. This leads to faster harvest of the stock and leave less resources for the future or even for the same generation. In such circumstances there is a need to regulate the fisheries to ensure optimal harvest of the resources.

The problem in fisheries sector is that because of the intrinsic characteristic of the open access nature of the fishery, implementation of any regulation measures becomes a difficult task. A few of the regulatory measures that has been formulated is described below.

Traditional Management-Total allowable catch (TAC)

The traditional management methods concentrated on the controlling of annual catch. The traditional management agency determines the total allowable annual catch (TAC). The cumulative years' catch is tracked and the fishery closed once the TAC is reached. Also the length of the fishing seasons can also be determined in advance, based on an estimate of the fleet's capture efficiency. With the correct estimate and reporting of catches, the TAC will provide an efficient management tool.

However the method has economic side effects. This include heavy competition from the vessel operators to take their share of TAC before the stipulated closing date. Hence they increase their vessel capacity and it has its own implications. In case of pacific halibut fisheries, the fishing season lasted for three days only in early 1990's. This also forced the fishermen to venture into the sea before the closure irrespective of the weather conditions, putting their life into risk.

Individual Transferable quotas (ITQs)

In this method, each fisher is allotted a specified annual quota, which may be caught as and when deisired by the fishermen. Quota units can be purchased or sold. The fishery management authority decides the total quotas.

In this method, economic rents are preserved and distributed among the quota owners. This eliminates competition among fishers. This has been successfully tested in Pacific halibut fishery in 1993 and US fishery in 1996. This also has a few disadvantages.

Taxes

The taxes imposed on the landed catches are another alternative method for regulation of fisheries. In this method, the net price received for the catch is reduced due to taxes. The taxes reduce the incentive for overfishing. If properly formulated and implemented a tax could help to achieve the desired effect in the regulation of fish. All the resource rents will be retained by the government in the form of tax revenues.

Responsible Fisheries Management

Objective

To ensure long term sustainability of living marine resources so that these can be harvested by generations to come thus making a substantial contribution to world food security and employment opportunities (Article 8 of Code of Conduct) (FAO, 1996)

Definitions

- **Fishing vessel** –vessel for commercial exploitation of living marine fishery resources, including mother ships and any other vessel directly engaged in such fishing operations
- **Fisher**- an individual taking part in fisheries from a fishing vessel, platform (whether fixed or floating) or from the shore
- **Owner**-an individual or entity holding shares in fishing vessel or fishing licence
- **Manager**-an individual or an entity acting on behalf of the owner for the operations of the fishing vessel or fishing operations
- **Charterer** –an individual or entity that leases a vessel for a fixed period of time or for a voyage
- **Fisheries Protection vessel** A vessel not engaged in commercial fishing and deployed by a State for monitoring, control and surveillance and law enforcement and is clearly identifiable being a government service
- **Transshipment**-the act of transferring the catch from one vessel to either another fishing vessel or to a vessel solely for the carriage of cargo

Application

The guidelines may be applied by the States on a *voluntary basis* to

1. All fishing operations on all oceans, seas and inland waters
2. Fishers, owners, managers masters of harbours of fishing vessels and competent authorities for the purpose of fisheries management and maritime transport
3. All fishing vessels engaged in transshipment of fishes

Conclusion

The economic performance of the fishing methods or vessels is the basis of any management measure. Unless the economic performance is in favour of the fishermen, he will not be interested to continue the business. The excess fishing capacity existing now is an indication of poor economic performance of the fishing methods.

It is time, we find out a middle point between biological and economic optimum involving all stakeholders so that practically implementable management measures can be formulated. We can even revisit the traditionally community based management practices followed sometimes back and scrutinize them for modification to the present needs and incorporate them into our present day management regimes.

The involvement of the stakeholders in the formulation of the fisheries management measures is very much essential for its successful implementation. Besides, a strong and committed will is required to enforce the formulated management measures for successful adoption of the responsible fisheries management measures by the stakeholders.

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Total Factor Productivity (TFP) as a fishery management indicator

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Introduction

Productivity indexes can be broadly expressed as either partial measures of productivity growth (relating a measure of output to a single measure of input) or Total Factor Productivity (relating a measure of output to all inputs). Total factor productivity is a measure of the productivity of all inputs, or factors of production, in terms of their combined effect on output and is often accounted for by technological change or more efficient methods of producing output. Technological change is the major determinant of long term economic growth and hence Total Factor Productivity growth serves as an indicator of the long term growth in an economy.

There are divergent views regarding what actually total factor productivity measure and the extent to which TFP can be taken as a measure of an economy's long-term technological change or technological dynamism. The conventional view is that TFP measure the rate of technical change (Law (2000) Krugman(1996)). In the long term, the new technologies transform the standards of living, economic, social and political ways of life, and even value systems of people. Much of the new technological knowledge is embodied in capital equipment whose accumulation is measured as gross investment. Hence technological change and investment are interrelated. Total factor productivity of an economy increases only if more output is produced from a given supply of inputs. Improvements in technology clearly increase total factor productivity. TFP measures all improvements in technology, including such things as the introduction of electricity, motorcar or technological progress leading to increased agricultural output or rapid technological shocks that are associated with information and communications technologies (ICTs).

The second argument suggests that TFP measures only externalities and other free gifts associated with economic growth. According to this view, the incomes generated by higher productivity are external to the economic activities that generate growth and these benefits spill over to income recipients not involved in these activities (Jorgenson, 1995).

The basics of total factor productivity measurement- The aggregate production function

Technological progress or the growth of total factor productivity is estimated as a residual from the aggregate production function. The aggregate productivity, mean the productivity of unique entities such as nations or entire industries.

Consider the simple Cobb-Douglas version of the aggregate function:

$$Y = AL^{\alpha}K^{\beta}, \alpha + \beta = 1$$

Total aggregate output is measured as Y . L is an index of aggregate labour inputs. K is an index of aggregate capital. Y , L and K are independently measured while A , α and β are statistical estimations. A is an index of the aggregate state of technology called total factor productivity. But changes in the number indicate shifts in the relation between measured aggregate inputs and outputs and in this aggregate model these changes are assumed to be caused by changes in technology (or changes in efficiency and/or in the scale of operations of firms).

The geometric index version of TFP is calculated by dividing both sides of the production function by $L^{\alpha}K^{\beta}$ to produce a measure of TFP:

$$TFP = A = \frac{Y}{L^{\alpha} K^{\beta}}$$

The growth rate measure of TFP is then calculated as an arithmetic index generated by taking time derivatives of both sides of the TFP expression w and r are the shares of output/income accruing to labour and capital.

$$a = \frac{wL}{Y}$$
$$b = \frac{rK}{Y}$$

Where w is wages paid to labour, and r is the real rental rate of capital.

$$\frac{wL}{Y} + \frac{rK}{Y} = 1$$

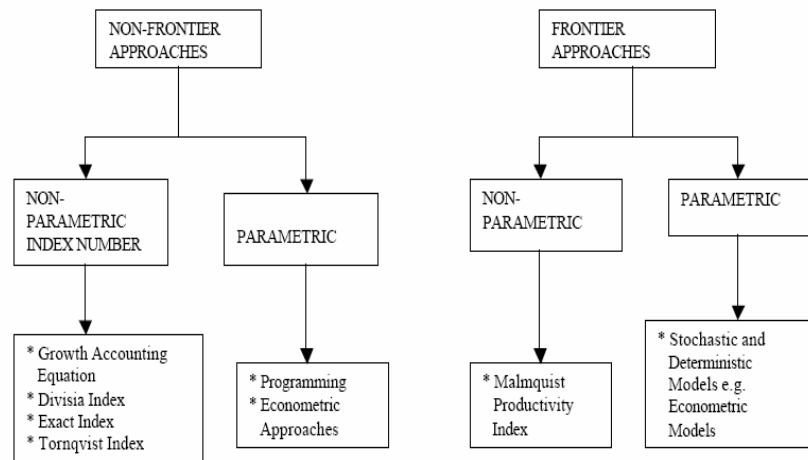
Changes in A indicate shifts in the relation between measured aggregate inputs and outputs. In the aggregate model these changes are assumed to be caused by changes in technology (or changes in efficiency and/or in the scale of operations of firms).

There are some conceptual and empirical problems concerning the measurement of TFP. These relate to the following issues: (1) a relevant concept of capital, (2) measurement of output, (3) measurement of inputs, (4) the place of R&D and public infrastructure, (5) missing or inappropriate data, (6) weights for indices. (7) theoretical specifications of relations between inputs, technology and aggregate production functions, (8) aggregation over heterogeneity.

Approaches to measure TFP

The approaches to total factor productivity measurement are generally classified into frontier and non-frontier approaches. The non- frontier approaches consists of parametric

and non-parametric methods. The growth accounting and indexing procedure comes under the non-parametric approach. Programming and econometric approaches are included under the parametric methods



There are different indexing methods for calculating the total factor productivity. Some of the most common of these are the Laspeyres index, the Paasche index, the Fisher index and the Tornqvist index. Most work on TFP uses a Tornqvist index, which is basically a percentage change index that averages base and given years weighted indexes. The Tornqvist quantity index is defined as the product across all goods of the ratio of current quantities divided by base year quantities weighted by the average of the base year and current year prices. The Tornqvist index is considered 'superlative' because of its capacity to approximate general functional forms of the production function. Tornqvist index is a discrete approximation to a continuous [Divisia index](#). A Divisia index is a weighted sum of the growth rates of the various components, where the weights are the component's shares in total value. For a Törnqvist index, the growth rates are defined as the difference in [natural logarithms](#) of successive observations of the components and the weights are equal to the mean of the factor shares of the components in the corresponding pair of periods. The Törnqvist index represents an improvement over constant base-year weighted indexes, because as relative prices of inputs change, the Törnqvist index allows both quantities purchased of the inputs to vary and the weights used in summing the inputs to vary, reflecting the relative price changes (Lipsey and Carlaw, 2001).

When TFP is calculated from a macro production function, the quantities used are the aggregate capital stock and the aggregate labour supply; when it is calculated from industry data, they will be industry capital and industry labour; similarly for firms, it will be each firm's capital stock and its employed labour. To get the basic quantities without any prior aggregation, extremely detailed micro data would be needed with a separate quantity input for each capital service. Thus, no matter how disaggregated are the physical quantities that are used for any calculation of a TFP index, they are typically aggregated over some group of heterogeneous capital goods (or capital services) by converting them to values. National productivity estimates are of special importance because they are an integral part in public policy making. However at this level of aggregation, the data available are limited to fairly short time series, which limits the scope for econometric estimation. As a

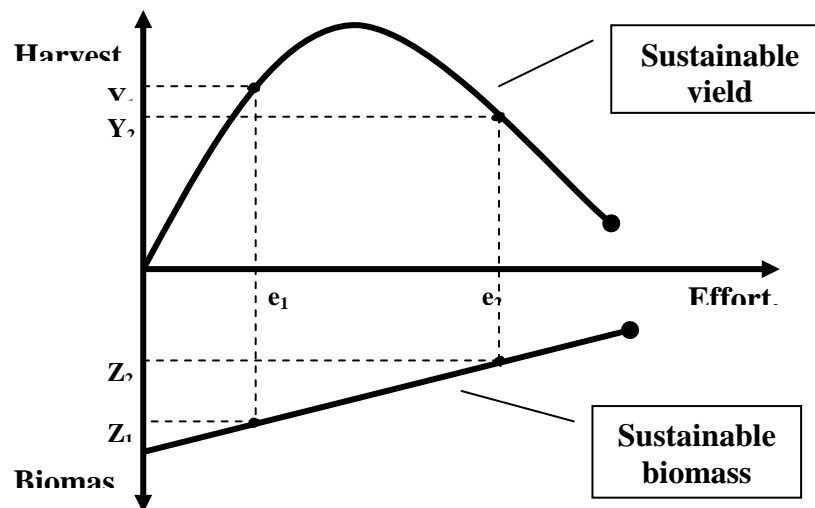
consequence, index number methods are most commonly employed for measuring TFP. Most studies have used the index number approach to measure productivity growth due to its easiness and less data requirements when compared to complicated econometric models.

Total factor productivity measurement in natural resources

Productivity growth in a fishery can generally be attributed to several factors. Improvement in technology (innovations) and adoption of technologies help to produce greater amounts of output for their inputs. Structural adjustment of a fishery's fleet towards more productive vessels (through exit and entry) will positively affect productivity- either through market forces or through government funded adjustment assistance. Change in the fishery resource stock- An increase in the abundance of fish stock leads to an increase in estimated productivity as fish can more easily be caught with relatively fewer inputs. Analysis of productivity trends for a fishery increases understanding of the fishery's ability to convert inputs into outputs and is also useful for assessing a fishery's overall economic performance. Availability of productivity estimates over a number of years enables trend analysis to determine key drivers of vessel level productivity growth-changes in the technology mix used in fishing, seasonal conditions and any changes in the regulatory environment.

Importance of fish stock in TFP measurement in marine fisheries

Several fisheries economists consider changes in a fishery's stock biomass as an important factor of productivity growth in marine fisheries. Adjusting for changes in the stock allows for a distinction between productivity changes due to fluctuations in the stock and productivity changes by changes in economic performance (Samuel Herrick and Dale Squires, 1990, Arnason, 2000, Hannesson *et al*, 2005).



Stock / biomas and sustainable yield

The curve in the upper half of the diagram represents the sustainable yield function which traces out the relationship between sustainable effort and the harvest. The line in the lower half of the diagram is the sustainable biomass curve which traces out the relationship between sustainable fishing effort and biomass. The effort level e_2 corresponds to output y_2 and biomass z_2 . Reducing the effort to e_1 will lead to an increase in the sustainable harvest to y_1 which shows an increase in productivity. But this is not true as the other input, biomass has increased to z_1 . There has been no shift in the production function and both production points lie on the same production possibility frontier (Arnason, 2000).

Hannesson(2005) studied the development of productivity in the Norwegian fisheries during the period 1961-2002 using data on catches at constant fish prices, capital stock, labour input and fish stocks. The total factor productivity has increased rapidly in the mid 60s which was proved to be due to technological progress.

Stephan (2013) analyzed the total factor productivity indexes of five key Commonwealth fisheries using the Fisher index. The TFP indexes were adjusted for changes in fish stocks where fish stock biomass information is available. The productivity increased over the last decade in most Commonwealth fisheries analyzed. These increases reflect a mix of government induced structural adjustments and management changes as well as autonomous adjustment responses to market conditions. Fishery management measures like the vessel buyback is expected to have increased industry level productivity as the least profitable (and therefore, least efficient) vessels exited the fishery-remaining vessels share a similar sized resource, with less crowding and competition, operated more efficiently and productively.

Total factor productivity- an application to the marine fisheries sector in India

Technological advancements took place in marine and aquaculture sectors in the form of improved mechanized fishing crafts and gears, seed, feed, and advances in marine and aqua farming technologies paved the way for increased fish production in the country. Analyzing the impact of productivity growth and quantification of factors leading to productivity growth occupies a significant role in developing a sustainable development plan for the marine fisheries sector in the country. The total factor productivity of marine fisheries in India was analysed for the period 2000-10. Gear wise and species wise catch - effort data and species wise average marine fish prices in different states of India obtained from Central Marine Fisheries Research Institute (Government of India) for the period 2000-10 were used for the analysis. TFP index was worked out using Divisia-Tornquist indexing method.

TFP index = $\frac{\text{Output index}}{\text{Input index}}$

$$\text{Input index} = \Pi_i (X_{it}/X_{it-1})^{(S_{it}+S_{it-1})/2} \quad (1)$$

Where X_{it} and X_{it-1} are the quantities of input i at time t and $t-1$

S_{it} and S_{it-1} are the shares of input i in total cost at time t and $t-1$

Similarly output index was worked out as follows:

$$\text{Output index} = \Pi_j (Q_{jt}/Q_{jt-1})^{(R_{jt}+R_{jt-1})/2} \quad (2)$$

Where Q_{jt} and Q_{jt-1} are the quantities of resource j at time t and $t-1$

R_{jt} and R_{jt-1} are the shares of resource j in total revenue at time t and $t-1$

t is the number of years (Kumar and Jha,2005).

Fuel, labour and fixed capital were used as the input variables for working out the input index. Fuel used in the marine fisheries sector of India consists of diesel and kerosene. The fuel used in the fishing industry was estimated based on average fuel consumption per hour of operation for all the fishing units. The data was validated by using total diesel sales data from the different diesel pumps, data from fishermen societies and information on diesel subsidy given by various state departments of fisheries. The data on kerosene was estimated based on the number of motorized units operated per year and average kerosene consumption per fishing trip. Labour employed in the marine fishing industry (Mechanized/motorized/Non-mechanized sectors) was estimated in terms of labour days. The fixed capital was estimated from the number of boats and investment details on each category of fishing unit.

The total factor productivity indices were developed based on the input and output indices calculated for the period 2000 to 2010. Fuel, labour and fixed capital used in the fishery were used for developing the input index. The average fuel consumption in the fishing industry varied from 1000 million litres and on an average every tonne of fuel produced 3.5 tonnes of fish. Mechanized trawlers are the prominent fishing units in the country and 76 percent of the fuel requirement in the fishing industry goes to the trawl sector followed by dolnetters(12 per cent), gillnetters (9 per cent) and others(3 per cent). State wise diesel consumption showed that the maximum diesel consumption is in the state of Gujarat where the maximum number of mechanized boats operates.

Labour used in marine fishing industry was estimated in terms of number of days employed per worker per annum. The labour consists of three categories- mechanized, motorized and non-motorized. The mechanized category included vessels of less than 20 m OAL, which used mechanization both for propulsion as well as for fishing operations. The motorized category consisted of outboard motor fitted boats and non- mechanized category consisted of the traditional wooden canoes without any engine. The labour cost included both wages and crew shares received by the fishermen. The average quantum of labour stood at 105 million days during 2000-10 and nearly 70 percent of which is contributed by the mechanized sector. The labour cost in the marine fishing sector was Rs.62 billion and the diesel cost was Rs.36 billion in 2010 at current prices.

The marine fish production increased from 2.65 million tonnes to 3.32 million tonnes during 2000 to 2010. Species wise analysis showed that the quantity of clupeids increased from 6.37 lakh tonnes in 2000 to 9.29 lakh tonnes in 2010. The quantity of other low value pelagics consisting of Bombay duck, half and full beaks, flying fishes, ribbon fishes, bill fishes and barracudas stood at around 3 lakh tonnes. The quantity of mackerels almost doubled from 1.34 lakh tonnes to 2.67 lakh tonnes. The resource wise average share in the gross revenue earned at landing centres during 2000-10 showed that the maximum share was contributed by crustaceans (40 per cent) followed by clupeids (11 per cent), low value demersals(9 per cent), cephalopods(8 per cent), seer fishes(6 per cent) and pomfrets(5 per cent). The output indices calculated from the quantities and revenue shares of the different resources during 2000 to 2010 period showed a growth rate of 3.4 percent.

The total factor productivity showed a positive growth of 1.65 percent during 2000-10 at all India level. The state wise analysis indicated that the total factor productivity

growth was positive in the east coast with a growth rate of 8.16 percent whereas in the west coast the total factor productivity growth was negative in the states of Kerala (-3.69%) and Maharashtra(-5.83%).

Table 1 : Total factor productivity growth of marine fisheries in different coastal states in India (2000-2010)

States	TFP growth (%)
West Bengal	6.42
Orissa	18.06
Andhra Pradesh	5.80
Tamil Nadu	4.18
Puducherry	13.75
East coast	8.16
Kerala	-3.69
Karnataka	2.88
Goa	4.52
Maharashtra	-5.83
Gujarat	3.15
West coast	-0.17
All India	1.65

The marine fish production in the major fish producing states of Maharashtra and Kerala showed declining catch trends of high value resources like shrimps and increase in the catches of low value fishes. Deshmukh (2006) reported that among 20 commercially important resources, Bombayduck, silver pomfret, elasmobranchs and lobster resources have declined significantly in Maharashtra. Even though there was substantial increase in marine fish prices in the past decade, the reduction in catches of high value fishes like crustaceans, high cost of fuel and labour led to reduced economic efficiency of fishing operations in Maharashtra and Kerala. The reduction in profit levels of fishing units may lead to reduced fishing effort in the long run with the characteristic boom and bust game of open access common property marine fishery resources. However efforts are necessary to manage the fishery based on some community based measures to improve the profitability of operations of fishing units and development and promotion of fuel efficient fishing methods.

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Harbour Based Fisheries Management in Thoothukudi District - A Case of Thoothukudi Fishing Harbour

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Introduction

Thoothukudi District having a coastal line of 163.5 km stretches from Vembar in the north to south of Manappad (i.e., between 8° 9' 00" to 9° 7' 30" N latitude and 78° 2' 30" to 78° 25' 00" E longitude). Thoothukudi fishing harbour (TFH) is one of the oldest fishery ports in the east coast of India. Due to its commercial and economic importance from the marine fisheries point of view, nowadays it is considered as one of the major fishing harbours on the east coast of India. For the sake of easy management the fishing areas are divided into north of Thoothukudi and southern Thoothukudi. Of which the southern area cover up to Chinna muttom in Kanyakumari district and northern side covers up to Ervadi in Ramanathapuram district. TFH is a landing centre which follows the unique rules and regulation of Tamil Nadu Marine Fisheries Regulation Act and Wild Life Protection Act as well. All the mechanized fishing vessels are operating above 3 Nautical miles from the sea shore and the fishing time is restricted between 5.00 am and 9.00 pm. Single day fishing and the fishery is characterized by multi-species, multi-fleet with multi-sized boats. Even though multiday fishing is economically beneficial but it is not followed for the sake of resource conservation and adherence to local socio-economic constraints.

The marine fish production of Thoothukudi fishing harbour was highly fluctuating from 2005 to 2012 and the annual catch has declined from 32,472 tonnes to 23,957 tonnes. The reduction in catch may be attributed to increased number of fishing units ultimately leading to less catch per unit effort and higher cost for fishing. For the sake of economic benefit fishers may catch the juveniles and non-targeted species as by-catch. Hence, there is a need to sustain the marine fisheries resources for the future generation, therefore an emphasis on management of the fisheries resource with different institutional participation coupled with different stakeholders plays a vital role. The present paper deals with various institutional arrangements exist in TFH for the management of marine fisheries and an exhaustive analysis made on the cost and returns of single day fishing.

Material and Methods

The primary data for a period of six months covering 2012 to 2013 was collected by simple random sampling method was used for the cost and returns analysis.

Net revenue = Total Gross Revenue - Total Expenses (Total Fixed Cost + Total Operating Cost)

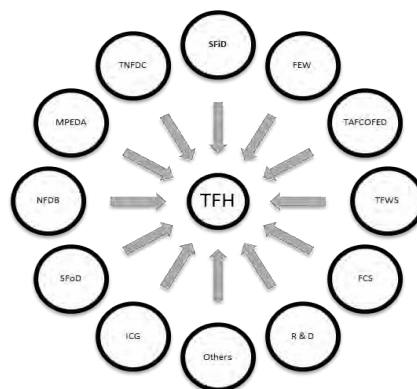
Facilities in TFH

TFH was constructed in 1968 which has 21 acres of reclaimed total land area and 2.7 acres of berthing area with a depth of 3 m to 4.5 m to accommodate about 400 medium sized mechanized trawlers. The length of the breakwater wall at seaward side is 1200 m. The fishing harbour includes different units such as jetty (800 m length), Warf (700 m length), two finger jetties (50 × 15 m), break water (150 m length), single sleep way (65 × 10 m), three auction hall, one ice plant, three Diesel pumps, one base workshop, one MPEDA storage, one overhead tank, five syntax tanks, office of Assistant Director of Fisheries (Thoothukkudi), Assistant Director of Fisheries (Fisheries Harbour Management) and Engineering Division of Director of Fisheries for construction and maintenance of existing Fishing Harbour. There are 307 mechanized fishing boats registered/re-registered with State Fisheries Department/Marine Product Export Development Authority (MPEDA). The number of boats added into operational fleet has gone up from mere two in 1998 to a maximum of 49 in 2010. The catches of the registered fishing vessels are landed in this harbour. The harbour has fish landing place with a separate hall/platform for prawns, lobsters, goatfishes, cephalopods, big fishes, small fishes, rays and trash fishes.

The ongoing National Fisheries Development Board (NFDB) project which includes fixing and strengthening of Warf, parking areas, loading areas, internal concrete road, improvement of electrical arrangements, sleep way renovation and extension of 6 m drainage. To enhance hygienic handling, the drainage was planned to include sewage treatment plant so that treated water will be used for washing the auction hall and remaining water could be pumped into sea.

Institutional arrangements in TFH

Figure 1: Various participants involved in Thoothukkudi Fishing Harbour (TFH)
SFiD – State Fisheries Department



The Assistant Director of Fisheries (Fisheries Harbour Management) plays a major role in overall management of the TFH. The Assistant Director of Fisheries (Thoothukkudi) is one of the leaders of the management committee of TFH.

State Fisheries Department is responsible for registering the fishing vessels when the length of the fishing vessel is less than 20 m or horse power of the engine less than 150 and if more that that registration could be done with MPEDA. The fuel subsidy was give only to the state fisheries department registered vessel under supervision of Inspector of Fisheries of TFH. The State fisheries department distributes the fuel to fishing vessel of 1500 liters per month or 15,000 liters per annum. All welfare scheme payment during ban and lean periods and other subsidizing schemes are distributed through State Fisheries Department. There is separate account for the regulation of fishing harbor management which regulates the activities in fishing harbor regularly. It includes fuel to fishing vessel, generator, fuel expenses, tube light charges, washing the fishing harbor after the auctioning, vehicle regulations etc.

FEW – Fisheries Engineering Wing

The Chief Engineer facilitates the construction and renovation of the TFH. The ongoing construction cum renovation work was funded by NFDB and is being carried out based on the fishers need.

TNFDC – Tamil Nadu Fisheries Development Corporation

The Managing Director provides facilities for fish marketing, construction and repair works at TFH. Supply of subsidized diesel and facilitation of kerosene for the fishing crafts are provided to the fishers under the control of TNFDC. TNFDC is the responsibility for creation of hygienic fish handling facilities at TFH.

TAFCOFED – Tamil Nadu State Apex Fisheries Cooperative Federation Limited.

The Special Officer provides and maintains diesel bunks and supply tax exempted diesel to TFH and it provides diesel to Vembar and Tharuvaikulam fishing villages of Thoothukudi district.

TNFWB – Tamil Nadu Fisheries Welfare Board

The Member-Secretary provides social security to the fishermen and laborers of TFH engaged in fishing and allied activities. TNFWB not only provide supports to fisheries management but also provides financial assistance towards educational scholarship for fisherman family, sea and accident death, physical handicraft, natural death, marriage and others.

MPEDA – Marine Product Export Development Authority

MPEDA plays a major role in production, induction of new technology, modernization of processing facilities, development of infrastructure facilities and market promotion. Under the fish production, financial assistance for constructing new fishing vessels, of Rs. 10 lakhs for vessel size between 18 and 20 m, Rs. 15 lakhs for vessel size more

than 20 m. MPEDA also provides financial assistance for the upgradation of existing fishing vessels for post harvest operation and preservation. MPEDA registration on high horse power engine fishing vessel in TFH helps in up-gradation of the processing and post-harvest operations. It also provides financial assistance for implementation of cold chain for better hygienic practices, onboard storage facilities and road transport facilities with cold storage.

FCS - Fisheries Co-Operative Societies

Extends much of the Government welfare Schemes to the members of TFH. Under these schemes fishers are getting Rs. 4000 during fishing ban period and Rs. 2000 during fish lean period.

NFDB- National Fisheries Development Board

NFDB provides financial assistance for the implementation and up-gradation of existing facilities of TFH. NFDB provided Rs.12.05 crores as a fund for the development of TFH. It helps for the handling and up keep of fishes in a more hygienic way.

SFoD - State Forest Department

The state forest officials play a vital role in policing the fishermen of TFH on catching the protected animals. It helps to regulate the marine fisheries management in a better manner. Island maintenance, monitoring, making awareness about endangered species etc. and also the department take strict action on fishers catching species.

ICG - Indian Coast Guard

Indian Coast Guard helps in patrolling and safeguarding the mechanized boats from TFH that enters in to the International Maritime Boundary Line. The surveillance of fisherman and protecting resources or depleted by entry other country fishers.

R & D - Research and Development Organisations

Central Marine Fisheries Research Institute, Fisheries College and Research Institute, Suganthi Devadason Marine Research Institute and Gulf of Mannar Biosphere Reserve Trust play an active role in Research and Development of Thoothukkudi Fishing Harbour. These organization gives advice for the management of fisheries stock, ecotourism to protect the endangered species, and sea ranching.

State Fisheries Department and Fisheries Associations

Department of fisheries plays an important role in dealing with the issues related to fishing regulation, conflict resolution and regulation of fishers welfare schemes. Additionally, the TFH has a fisherman cooperative society, of which all the fishermen are members but it was differentiated into labour and owner society.

All the mechanized boat owners are organized under the Thoothukudi boat owners association. Each member of this association has ownership of single or multiple fishing vessels. This organization comes under the labour union at the district level. One of the major activities of this association is conflict management between labour and owner, country boat and mechanized boat. For instance, when a conflict needs to be resolved, representative from country boat and another representative from mechanized vessel, have a meeting with association along with officer from state fisheries department. Generally, two type of gear damage issues are dealt by the association i.e. identified fishing vessel and non-identified fishing vessel. The decision is made between the representative of country craft and mechanized craft in the presence of officials from fisheries department.

Associations are formed independently and as per need they formulate their own rules and regulation within the association. For example, Muthu nagar vessel association was divided into two groups on the basis of vessel size, are of less than 50 m and more than 50 m length.

These associations also describe the banned fish species as well as creating awareness towards the member. If any mistakes happened they won't get any support from the association to escape on the crime. Due to single day fishing, fishers are not getting enough time to get the catch, many days they returned to shore without meeting the operational expenses. It may not be economically viable but in biological point of view it is good and sustainable. To meet the expense the fishers are forced to catch juveniles and non-targeted species.

Usually, fishing time is between 5.00 am and 9.00 pm. The fishing vessel has to leave the shore at 5 am of the day and return back to the shore or enter in the harbour before 9 pm. There will be a penalty for later departure and chain in the entry point opened only after the payment. The time management was regulated by State Fisheries Department.

Wind season is traditional methods of identifying the fishing season till followed by TFH fishers and on the basic of season they are categorized into four fishing periods, such as 'Sirukodai' between mid-April to mid-August, 'Kontal kaatru' for the period of mid-August to September, October and November are rainy season and 'Vaadai Kaatru' during the month of December and January.

Management committee

The fishing vessel owner association selects a leader and creates a joint account with the Joint Director of Fisheries (Thoothukudi) and each vessel owner will deposit money to that account once in a month. The deposited money is used for the management of harbour such as maintenance of the harbour lights, generator fuel etc. Vehicle entry token/pass has been maintained by the State Fisheries Department officials to maintain and regulate the harbour management in TFH. The amount charged for different vehicles entering in the TFH are given in the table.

Table 1: Entry fee for different vehicles at TFH.

Sl. No	Vehicle	Rs/vehicle	Minimum and maximum no of vehicle
1	Cycle	2	110-130
2	Two motorcycle	5	120- 160
3	Load Auto	50	21-35
4	Ice breaker	50	25
5	Jeep	50	51-65
6	Van 407	100	12- 20
7	Tata ace	100	87-110
8	Covered ice truck	200	19-30

Management during Seasonal Banns

Capture fisheries in Thoothukudi fishing harbour has been banned from 15th April until 29th May. The decision was taken by the Ministry of Agriculture, Animal Husbandry and Fisheries and agreed by industry representative. This measure allows for protection of the species, enabling it to regenerate. In East coast fishing was closed for 45 days, during this scheduled time to conserve stock.

Fisheries Legislation:

According to the Tamil Nadu Marine Fisheries Regulation Act (1983), multiday fishing was banned in entire Tamil Nadu, but these rules was not followed by all the marine fishing coastal districts of Tamil Nadu but it is exception in Thoothukudi district. From the management point of view, the Wild Life Protection Act, Tamil Nadu Marine Fisheries Regulation Act, state and central government rules are regulating the rules and regulation in fishing actives. The coast guard as well as state fisheries department are monitoring the fishing actives in Thoothukudi fishing harbour.

The average annual capital investment was Rs. 27, 10,000, which can generate a net perfect income of Rs 14, 23,510 through fishing activities in TFH. The analysis shows that, the investment cost is very high and operating cost constitutes 75 to 80 % of the gross revenue. However, the annual average fishing days are around 187 days for mechanized fishing crafts which operates in TFH. The interest rate of capital investment was 12%, and annual depreciation was computed by the straight line method.

Economic Analysis of Single Day Vs Multiday Fishing

The single day and multiday fishing economics of India was estimated by the Narayanakumar *et al.* (2009). This result showed that multiday fishing has been generating higher gross revenue per fishing trip as compared to single day fishing. But, Thoothukudi

fishing harbour has been regulating single day fishing, even though one knows about benefits of multiday fishing. It shows an importance given to preserve resources.

Table 2. Economics of Fishing at TFH

Particulars	Details of amount (Rs.)
Capital investment of mechanized fishing unit	27,10,000
Annual fixed cost	
Annual depreciation	2,43,900
Interest loan for capital investment (12%)	2,43,900
Berthing charge	8,700
Vessel registration fees	83
Total fixed cost (A)	4,96,583
Annual operating cost	
Fuel	80,19,756
Bata	32,83,700
Food	4,38,455
Ice	4,37,265
Auction charge	13,80,037
Repairs and maintenance	61,200
Total operating cost(B)	136,20,413
Total cost per year (A+B)	141,16,996
Annual average catch (tonnes)	2,59,718
Gross revenue (Annual)	164,50,620
Net profit without deducting the labour remuneration	23,33,623
Labour remuneration/ year	910,113.2
Net profit	14,23,510
Average annual fishing days	187

Table 2: Economic performance of single day trawling (2001-2005).

Sl. No	Details	East coast	Percent to total	West coast	Percent to total	All India	Percent to total
1	Wages	2266	38.35	1766	23.39	2016	34.13
2	Food & bata	134	0.44	30	0.29	82	1.39
3	Auction charges	1040	1.41	161	5.86	601	10.17
4	Others	594	0.84	449	1.10	521	8.82
5	Total operating cost	7361	100.00	4454	100.00	5907	100.00
6	Gross revenue	15714		7465		11589	
7	Net operating income	8353		3012		5682	
8	Capital productivity	0.60		0.60		0.60	
9	Catch per trip	471		373		422	
10	Average crew size	6		6		6	
11	Labour productivity	86		62		74	

(Catch per trip in kg; Labour productivity in kg/crew/trip)

Source: Narayanakumar *et al.* (2009).

Table 3. Economic performance of multi-day trawling (2001-2005).

Sl. No	Details	East coast	Percent to total	West coast	Percent to total	All India	Percent to total
1	Fuel	17749	55.11	18392	59.73	18070	57.37
2	Wages	9416	29.23	6968	22.63	8192	26.01
3	Food & bata	293	0.91	289	0.94	291	0.92
4	Auction charges	1160	3.60	1363	4.42	1261	4.00
5	Others	3591	11.15	3781	12.28	3686	11.70
6	Total operating cost	32207	100.00	30792	100.00	31500	100.00
7	Gross revenue	56274		49199		52737	
8	Net operating income	24067		18407		21237	
9	Capital productivity	0.58		0.62		0.60	
10	Catch per trip	1675		1891		1783	

11	Average crew size	7	7	7
	Labour productivity	251	276	263

(Catch per trip in kg; Labour productivity in kg/crew/trip)

Source: Narayanakumar *et al.* (2009).

The analysis study showed that higher economic benefit was found in multiday fishing for east coast, west coast and at all India level. In the east coast of India for multiday trawling the operating cost was Rs. 7,361 gross revenue at Rs. 15,714 and the remaining Rs. 8,353 is the net profit, but in the case of 2-5 multiday fishing, profit was around Rs. 24,067 and operating cost was Rs. 32,207, which had the gross revenues around Rs. 56,274. The above example indicates that, multiday fishing earns higher benefit as compared to single day fishing.

Conclusion

There is a need to preserve and sustain the marine fishery resource of India, which is dwindling fast. Better management of marine fishery resources is the need of the hour considering the livelihood of the fishers and augmenting the availability of animal protein to growing population. Single day fishing was not strictly followed in most districts of Tamil Nadu as it not economical and lucrative as that of multiday fishing. For sustainable harvest, marine resource has to be managed by following the rules and regulations and fishers should make use of institutional support and policy measures to conserve the marine fishery resource for the future generation.

Fisheries sector in India : Export trade perspectives beyond WTO

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Introduction

The WTO's Doha Agenda For Fisheries

Once again secret deals are being cut in back rooms by corporate-dominated and little known international trade groups that will directly impact the lives of commercial fishermen and our industry for decades to come. In this account we will explain that threat and help guide you through the 'trade-speak' maze as well as tell you what you can do to see that fishermen's concerns are addressed. The outcome of this struggle really matters. What happens in this fight will directly affect your markets, your price and even whether you will still be able to go fishing in the future. In one-way or another, the issue affects us all.

After failing famously in Seattle in November 1999, the World Trade Organization (WTO) finally succeeded in launching a new round of trade talks in November 2001. Two years following the "Battle in Seattle," trade ministers from 140 nations agreed to expand the WTO's scope over fisheries policies worldwide.

As signed in Doha, Qatar, world governments have agreed to begin negotiations in key areas of fisheries policy, making these issues, which have traditionally been decided in local or national arenas, an international trade agenda item. Everything from gear requirements to labeling requirements to fishermen's federal pensions could be impacted. Once again, fishing men and women, and the coastal communities they support, have been shoved out of the rule-making process and currently have no voice at the table (see the November, 1999 FN article "The World Trade Organization (WTO): Flying Under Fishermen's Radar," available on the Internet.

Countless popular movements have roundly criticized the WTO as a threat to democracy and the public interest. By joining the WTO, our government restricts what its own citizens can do to sustain fisheries and fishing communities, as well as set limits on the behavior of large corporations. Thus fisheries policy-making is increasingly moving offshore, to the arena of international trade negotiations between nations. As a result, nearly every national fishery management policy, tool or conservation program that might restrict corporate access to fisheries or seafood markets could, potentially, be classified to be a violation of the rules of global free trade.

Non Agricultural Market Access (NAMA)

A key element of the Doha Round of trade negotiations of the World Trade Organisation (WTO) is liberalisation of trade in industrial products, commonly known as non-agricultural market access (NAMA). NAMA refers to all products not covered by the Agreement on Agriculture. In other words, in practice, it includes manufacturing products, fuels and mining products, fish and fish products, and forestry products. They are sometimes referred to as industrial products or manufactured goods. A tariff binding is a ceiling above which a member country cannot apply a tariff, thus representing the maximum tariff than can be applied by a member. The NAMA negotiators have opted in favour of a formula approach to tariff reductions rather than a linear approach. The Swiss formula, which has been propounded by the developed countries such as the US, the EC countries, Norway, and Japan, proposes to cut tariffs steeply without taking account of the existing tariff profile of a country. The modified Swiss formula, on the other hand, takes into account the tariff profile of the countries while carrying out tariff reductions. This approach is supported by the developing countries, group of eleven developing countries working toward strengthening NAMA. The group has two main objectives of supporting flexibilities for developing countries and balance between NAMA and other areas under negotiation. The Member countries of NAMA-11 are Argentina, Bolivarian Republic of Venezuela, Brazil, Egypt, India, Indonesia, Namibia, Philippines, South Africa and Tunisia. NAMA products have accounted for almost 90 per cent of the world merchandise exports.

Negotiation under NAMA focus on market access for all products (mostly industrial) that are not covered by negotiations on agriculture and aim to reduce, if not possible to completely eliminate tariff or non-tariff barriers (NTBs) that restrict trade in these products. NAMA negotiation also considers products including natural resources such as fisheries, forests, gems and minerals. The ongoing NAMA negotiations are based on the mandate given in Doha Development Agenda (DDA), agreed at the 4th WTO Ministerial Conference, in November 2001. The Doha mandate states that the negotiation needs to address tariff peaks, tariff escalation and NTBs. The Doha text also states that, there is need for comprehensive product coverage under NAMA and less than full reciprocity i.e. developing countries need to reduce tariff to a lower extent than industrialised countries and spread commitment over a longer time period. Further, the modalities to be agreed under NAMA include appropriate capacity building measures to assist least developed countries to participate effectively in negotiations. July Framework also, as adopted on August 2004, identified NAMA as the priority area along with the other issues of WTO and reaffirmed on

what was promised in Doha to reduce the tariffs and NTBs and address tariff peaks and tariff escalation, taking fully into accounts the special needs and interest of developing and least developing countries (LDCs). India wants to gain greater market access in the developed countries, not much through the reduction of their tariffs, which are already low but through the dismantling of NTBs to trade and some GSP [e.g. the proposed EU-GSP on (T&C)]. India will also like to resist sharp reduction in tariffs forced open upon by developed countries. It will reduce tariff autonomously at a pace it judges suitable for the Indian industry. India will accept any tariff reduction formula only on bound rates and will counter any attempt to use applied rates as the base for application of a tariff reduction formula. India wants an equitable tariff reduction formula in the negotiations keeping in view the concerns of the developing countries. India endorses the suggestion put forward by US for using two different coefficients for tariff reductions – one for the developed country and one for the developing countries, but with a lot of fine-tuning, rather than using the Swiss Formula. India is also against the proposal of a mandatory ‘zero for zero’ reduction on the seven specific products by 2015 as these constitutes the bulk of the India’ export basket and are also product reserved for the small-scale sector. A ‘zero for zero’ regime would spell their doom by granting unmitigated access to large foreign firms in the same market. India also highlights the need to link adoption of tariff reduction formula with concrete time bound progress on eliminating NTBs.

Seafood is high on the global trade agenda and has become particularly relevant in the light of the entry of fisheries into the WTO process (following WTO Doha Ministerial Conference in December 2002). International trading regimes are changing, with more open market access but with EU, US and other developed countries taking increasingly stringent measures for seafood safety. Changes in market access are likely to have significant implications for poor producers, and costs of implementation of international fisheries agreements, such as WTO sanitary and Phyto sanitary (SPS) measures, HACCP standards, and market-driven labeling schemes may reduce livelihood options through barriers for participation of poor people. Liberalization of economies coupled with increasing demand for value added products and other product diversifications has resulted in structural changes of seafood industry in the last decade. Indian seafood exports declined to \$1.89 billion from 2.10 billion dollars during 2007-08. The global financial meltdown seems to have taken its toll on the export of marine products from India with the business recording a 10 per cent slump to \$1.9 billion for the year 2007-08. The country may even fall short of its target of \$2 billion set for 2009, reports which was hit mainly due to economic recession in Europe and America, which are the major importers of marine products from India. The provisions under the various WTO agreements are expected to have an impact on the different dimensions on the Fisheries sector.

WTO and Indian fisheries

With the implementation of the New Economic Policy in July 1991, and the subsequent focus on terms of trade and gains from trade, seafood was identified as a major source of foreign exchange earner for the country. The founding of the World Trade Organization (WTO) in January 1995 marked the culmination of a series of complex, arduous and long drawn out negotiations under the Eighth Round of General Agreement

on Tariffs and Trade (GATT). It also marked the beginning of a distortion free multilateral trade among the economies of the World as the core principle of the WTO is institutionalization of global framework for deregulated competitions. India, being a founder member of the GATT, is a signatory to the commitments made during the negotiations.

The provisions under the various WTO agreements are to have impact on the different dimensions on the Fisheries sector. The main provisions of WTO agreement that are applicable to fisheries are:

1. Trade related intellectual property right (TRIPS) and imposition of patent regime.
2. Trade related investment measures (TRIMS).
3. Reductions of domestic and export subsidies.
4. Tariff reduction and bindings to provide market access.
5. Removal of quantitative restrictions (QR).
6. Application of sanitary and Phyto-sanitary (SPS) measures.
7. Aggregate Measure of Support (AMS).

The implications are discussed below under the following heads

- (a) Export performance over the years
- (b) Recession and its impact on India seafood trade
- (c) Debate on Subsidy
- (d) Sanitary and Phytosanitary measures
- (e) Exporters profiling and constraint analysis of exporters
- (f) Tradeoffs between domestic marketing and international trade
- (g) Trade and resources

A. Export performance over the years

There has been commendable increase in the Indian fisheries export in terms of quantity, value and unit value over the years. The results are given below in the following tables.

Table 1: Export growth of marine products – Post and Pre WTO (Commodity)

Year	Pre -WTO (1979-1995)	Post WTO (1996-2012)
Total		
Quantity (tonnes)	3.49*(1.53)	8.27* (2.763)
Value (Rs)	3.33** (1.50)	8.21* (2.58)
Value (US \$)	3.31* (1.80)	6.95* (2.12)
Unit Value (Rs)	-0.15 (-0.10)	1.14(0.24)
Frozen Shrimp		
Quantity (tonnes)	0.83 (0.80)	5.36* (2.67)
Value (Rs)	1.95 (0.89)	7.93* (2.36)

Value (US \$)	1.92** (1.01)	6.72* (1.99)
Unit Value (Rs)	1.11 (0.68)	2.45* (1.40)
Frozen Lobster		
Quantity (tonnes)	12.88* (2.94)	2.54(0.64)
Value (Rs)	16.05* (2.64)	4.97* * (0.83)
Value (US \$)	16.03* (2.98)	3.79(0.65)
Unit Value (Rs)	2.80 (0.83)	2.36* * (0.89)
Frozen Squid		
Quantity (tonnes)	16.26*(2.24)	7.54* * (1.02)
Value (Rs)	16.64* (2.04)	9.37* * (1.02)
Value (\$)	6.61* (2.07)	9.14* * (0.92)
Unit Value (Rs)	0.48 (0.15)	2.69* * (0.90)
Frozen Cuttlefish		
Quantity (tones)	16.03* (3.62)	7.62* (1.58)
Value (Rs)	26.64* (2.04)	7.04* * (1.05)
Value (US \$)	26.61* (2.07)	4.66(0.68)
Unit Value (Rs)	0.48 (0.06)	-0.53(-0.24)
Fresh and Frozen Fish		
Quantity (tones)	3.49 (0.41)	11.6* (2.29)
Value (Rs)	8.18 *(1.35)	9.56* (1.98)
Value (US \$)	8.15* (1.42)	8.34* (1.75)
Unit Value (Rs)	4.52** (1.14)	1.85* (1.66)
Others		
Quantity (tonnes)	-5.45** (-0.90)	13.62* (1.80)
Value (Rs)	-6.23** (-1.03)	27.41* (1.13)
Value (US \$)	-6.25** (-1.12)	27.45 (1.08)
Unit Value (Rs)	-0.83 (-0.11)	12.17* (0.77)

Figures in parenthesis the standard errors of the estimates
indicate ** one per cent level of significance * five per cent level of significance

Table 2: Export growth of marine products – Post and Pre WTO (Market wise)

Year	Pre -WTO (1979-1995)	Post WTO (1996-2012)
Total		
Quantity (tonnes)	3.49*(1.53)	8.27* (2.763)
Value (Rs)	3.33** (1.50)	8.21* (2.58)
Value (US \$)	3.31* (1.80)	6.95* (2.12)
Unit Value (Rs)	-0.15 (-0.10)	1.14(0.24)
Japan		
Quantity (tonnes)	-0.06 (-0.06)	3.75* (1.00)
Value (Rs)	0.91* (0.45)	5.03* * (1.02)

Value (US \$)	0.92* (0.51)	3.90(0.77)
Unit Value (Rs)	0.97 (0.52)	1.25 (0.59)
USA		
Quantity (tonnes)	2.62*** (0.75)	8.19* (3.57)
Value (Rs)	3.36** (0.77)	14.79* (3.49)
Value (US \$)	3.38** (0.93)	14.27* (3.59)
Unit Value (Rs)	0.72 (0.51)	14.73* (3.48)
European Union		
Quantity (tonnes)	3.66 *(1.61)	11.68(1.17)
Value (Rs)	1.26* (1.53)	4.64(1.23)
Value (US \$)	1.28* (1.62)	4.62* (1.62)
Unit Value	1.11** (1.08)	4.35* (2.06)
South East Asia including China		
Quantity (tonnes)	2.14*	13.86* (2.04)
Value (Rs)	4.23	12.54* (1.38)
Value (US \$)	4.38	11.32(1.23)
Unit Value (Rs)	0.48**	1.15(0.31)
Middle East		
Quantity (tonnes)	3.42**	5.19(0.85)
Value (Rs)	2.13	7.84 (0.82)
Value (\$)	2.32*	6.69(0.69)
Unit Value (Rs)	1.24**	2.51(0.45)
Others		
Quantity (tonnes)	2.84 (0.45)	18.18* (1.52)
Value (Rs)	6.07** (1.13)	24.39* (1.58)
Value (US \$)	6.09** (1.08)	23.05* (1.51)
Unit Value (Rs)	3.14 (0.63)	5.26* (1.55)

Figures in parenthesis the standard errors of the estimates
indicate ** one per cent level of significance * five per cent level of significance

Inorder to examine quantitatively the effect of export quantity and the export unit value and their variability on the export value over the year's decomposition analysis was performed. For better understanding the variance of the export value was measured in two-time period *viz.*, pre WTO

period (1979-1995) and post WTO period (1996-2012). The export quantity and export unit value of Indian fisheries were detrended for further decomposition analysis.

Decomposition analysis was done for decomposing the sources of growth on average export value and variance of export value of Indian marine products

Table 3: Decomposition analysis of the components of change in average export value of Indian marine products

Sl. No:	Source of Change	Percentage Share
1	Change in Mean Export Unit Value	8.19
2	Change in Mean Export Quantity	79.92
3	Interaction between changes in (1) and (2)	9.79
4	Change in EQ-EUV covariance	2.20

The results indicated that the contribution of change in mean export quantity was the highest among the other components of change i.e. the increase in mean export quantity accounted for 79.92 per cent of the increase in average export value. This was as expected because the export quantity had recorded significant higher growth rates during both the period whereas the export unit value recorded a negative growth rate during the post WTO period. The changes in the covariance between the mean export quantity and mean export unit value accounted 2.20 per cent increase in the mean export value. The changes in the covariances could arise through the changes in the variance of export quantity and export unit value. With regard to interaction effect the export quantity was benefited to a small extent (9.79 per cent) from both mean export quantity and mean export unit value. Among the various components, the contribution of change in mean export quantity of Indian marine products was the dominant source for the change in average export value followed by the interaction between changes in the mean export quantity and mean export unit value.

A. Export performance over the years (recession)

Recession is defined as the significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in production, employment, real income, and other indicators which started in 2007-08 (mostly in developed economies). There exists a lag in recession especially with regard to food demand .The impact has been noticed since first quarter of 2009.

The impact of recession was studied and it was found that recession has not affected India's seafood trade. The major reasons for the same had been India- economic stimulus, strength of banking system, Developed countries - Purchasing power and employment rate decreased by around double digits as the demand for retailing gone up and lower demand

for ready to serve and ready to cook .The demand for food stamps (PDS increased in the developed countries including US and EU amidst massive economic stimulus provided. The China - Stronger Yuan and remain unaffected. In the South East Asian countries was countered by more productivities and governmental regulation .The Indian seafood export wasn't affected due to the Increased demand for raw fish rather than value added products from the retail outlets , declining international market arrivals by over 10 per cent globally in the buyer countries .It was found that the quantity and value are on the high and the emergence of newer markets in Latin American, African (3.5 and 4.2 per cent Quantity and Value).However there are concerns of Unit value declining over the period - case of concern and Growing concern of depreciating rupee compared to dollar increased the earnings and the reduction in the import to China (but channeled through Vietnam was a concern)



Fig. 1: Recession and India's export trade

B. Export performance

The export performance was based on a matrix referred to as Growth Constancy Retention matrix (GCR) based on the secondary data collected from secondary data from 1975-2011>the study covered the Geographic concentration of 35 countries and the commodity concentration- species and different forms .The matrix is represented below in Figure 8. The parameters used in the matrix include:

- Growth estimated using compound growth rate HG, MG, LG, MIG
- Constancy - using Stability index- HC, MC, LC, MIC
- Retention- brand loyalty of Indian products estimated using weighted average
- HR, MR, LR, MIR

The estimation of the parameters are done using

G- Growth estimated using compound growth rate

$$r = (\text{Anti Ln of } b - 1) \times 100$$

C- Constancy done using Stability index

$$\text{The instability index} = (\text{antilog } g - 1) \times 100 \dots\dots\dots (g)$$

Where,

X_t = Value of exports in year t or volume of exports in year t

N = Number of years - 1, m = The arithmetic mean of the difference between the logs of X_t and X_{t+1} , etc., $V \log$ = Logarithmic variance of the series

R- Retention- brand loyalty of Indian products estimated using weighted average)

Growth -Constancy -Retention Matrix

Growth/ Constancy	High		medium		Low		marginal	
High	HR	MR						
	LR	MLR						
Low								
Medium								
Marginal								

HR,MR,LR and MLR Indicates different levels of retention

Figure 6.2 Growth -Constancy -Retention Matrix

The analysis of the Growth Constancy matrix indicated that there exist stable partners across the export destination with sizeable export quantities

(C) Antidumping

Anti-dumping duty had a major impact on shrimp exports to the US which plummeted from \$409 million in 2003 before the duty imposition to \$142 million in 2008. The exports to US have considerably increased after the reduction in the antidumping duty from 14.29 to 0.79 during 2008-09 (Figure 27A). Subsequent increase from 0.79 to 2.14 per cent(2010-11) hadn't shown any effect on the shrimp exports to United States for now an increased to 452 million \$ during 2010-2011.

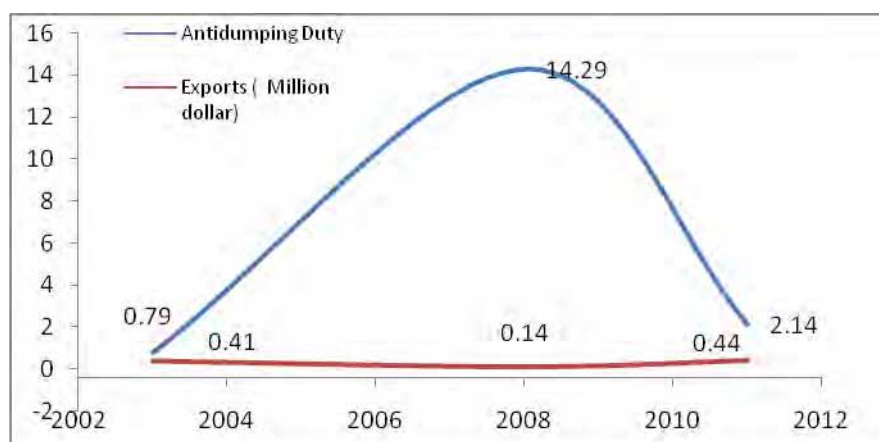


Fig. 2 Antidumping duties and changes in export quantum to US

(D) Sanitary and Phyto sanitary measures

The analysis of the short run and long run gains on the SPS and compliance measures by the exporter's analysis indicated that with the huge cost of investment required for the compliance of EU approval and HACCP implementation the gains weren't significant due to non-capacity utilization of the processing plant and lack of raw materials. The processing plants which have implemented the compliance investment for the EU approval are yet to break even their cost of investment even after 8 -10 years on account of processing capacity utilization to the tune of 22-25 per cent.

Nitro furan metabolites, concentration of heavy metals, occurrence of histamine and bacterial inhibitors were the major reasons for the EU rejections of Indian marine products. Belgium, Spain, Greece and UK were the major countries which rejected the consignments during the period the present antibiotic residues level required by the EU for seafood exporters are extremely rigid and beyond the actual requirement of food safety

(E) Fisheries Subsidies

Fuel subsidies, preferential tax treatments, boat construction subsidies comes under the WTO definition of subsidies set forth in WTO Agreement on subsidies and countervailing measures. According to UNEP the different subsidies to fisheries sector consists of fishing infrastructure (construction of harbours and port-facilities, management services (monitoring and surveillance, management related research, subsidies to securing fishing access, subsidies to decommissioning of vessels, subsidies to capital costs, subsidies to variable costs income supports and price supports. In India the different types of subsidies includes, subsidies to marine fisheries development (motorization of crafts and reimbursement of excise duty or sales tax exemption on fuel, subsidies for kerosene, construction of fishing harbours and other infrastructure, support for domestic marketing, processing facilities, subsidies for promotion of aquaculture, subsidies for different institutions for research and development, and export subsidies. Among the different items,

subsidies to marine fisheries development infrastructure and post-harvest operations and export subsidies are considered as harmful subsidies. The adverse effect of subsidies depend on the existing management regime and the bio economic conditions of the fishery. Subsidies lower the cost of harvest and raise the effective price of fish. As a management tool, cost-reducing or profit-increasing subsidies may result in increased productive efforts and hence considered as harmful through overexploitation of fish resources and unsustainable harvesting (eg. Export promotion subsidies results in targeted fishing and trade diversions).

Classification of Subsidies

The classification of subsidies under the different head *viz.*, Good (Beneficial), ,Bad (Capacity enhancing) and Ugly (Ambiguous)is furnished in Table

Table 4 : Classification of subsidies

Sl.No:	Type of Subsidies	Details
1.	Good (Benficial)	Lead to investment in natural capital assets. They enhance the growth of fish stocks through conservation, and the monitoring of catch rates through control and surveillance measures to achieve maximum long-term sustainable net benefits
2.	Bad (Capacity enhancing)	Programs that lead to disinvestments in natural capital assets such that the fishing capacity develops to a point where resource overexploitation makes it impossible to achieve maximum sustainable long-term benefits.
3.	Ugly (Ambiguous)	Programs whose impacts are undetermined, i.e., they may lead to either investment or disinvestment in the fishery resource. These subsidy programs can lead to positive impacts such as resource enhancement programs or to negative impacts such as resource overexploitation.



Fig. 2: Fisheries Subsidies in the world (Billn \$)

Table 5 : Quantification of subsidies across the world

Type of Subsidies	Total	Share to total value
Bad Subsidies, including fuel	16.20	25.00
Fuel subsidies alone (27 per cent of bad)	6.20	9.57
Ugly Subsidies	3.00	4.63
Good Subsidies	8.00	12.35
Total subsidies	27.20	41.98
Developed (Per county basis - 3 times)	18.50	68
Developing	8.704	32

Table 6 : Categorisation of fisheries subsidies in the world

Countries	Beneficial - Good	Capacity enhancing - Bad	Ambiguous - Ugly	Total
Japan	0.59	3.39	0.65	4.64
EU	1.26	2.59	0.72	4.57
China	1.23	2.19	0.73	4.14
USA	1.16	0.44	0.20	1.80
Russia	0.32	1.04	0.12	1.48
India	0.18	0.85	0.04	1.07
WORLD	8.00	16.2	3.00	27.2

Table 7: Subsidies in select countries - Subsidy per tonne of fish

Sl.NO:	Country	Total	Bad	Fuel subsidy	Landings	Total	Fuel
1 .	Japan	4.64	2.6	56.03	4.21	1102.14	617.58
2 .	EU	4.57	3.4	74.40	5.83	783.88	583.19
3 .	Spain	0.67	0.48	71.32	1.23	547.15	390.24
4 .	France	0.43	0.36	82.57	0.89	489.89	404.49
5 .	China	4.1	3.1	75.61	14.65	279.86	211.60
6 .	US	1.8	1.4	77.78	4.72	381.36	296.61
7 .	Russia	1.48	0.98	66.22	3.45	428.99	284.06
8 .	India	1.07	0.23	21.30	3.10	348.39	74.19

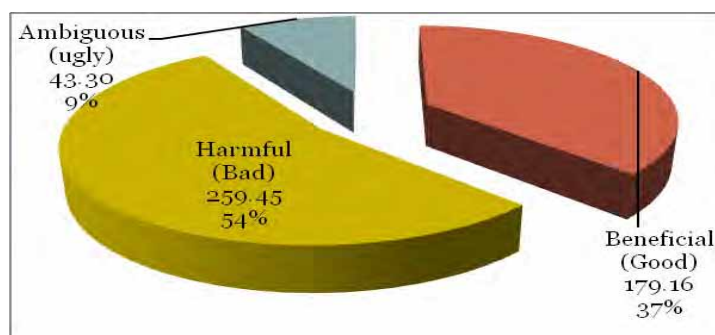


Fig. 3 : Categorisation of fisheries subsidies in the world

Table 8 : Quantification of Indian fisheries subsidies

Beneficial (Good)	Million \$
Fisheries management and services	117.84
Fisheries research and Development	60.00
Maintenance of MPAs.	1.32
Sub total	179.16
Harmful (Bad)	
Boat construction,	27.17
Fishery development and support services	29.14
Fishing port construction and renovation	133.38
Marketing support and storage infrastructure	24.44
Tax exemption	0.31
Foreign access agreements.	0.00
Fuel subsidies (Annual consumption of 1000 million litre)	45.00
Sub total	259.45
Ambiguous (Ugly)	
Fisher assistance	4.15
Vessel buyback	0.00
Rural fisheries community development	39.15
Sub total	43.30
Grand total	481.91

Table 9: Fisheries Subsidies during 2010-2011

A.	(Marine Landings -3.12 Million tonnes) Value of landings at landing centre- crores	4893.25 Million \$	19573 crores
B.	Value of marine landings at Retail centre-	6443.25 Million \$	25773 crores
C.	Total subsidy breakup (Million \$)		
(i)	Beneficial (Good)	179.16	(37.18)
(ii)	Harmful (Bad)	259.45	(53.84)
(iii)	Ambiguous (ugly)	43.30	(8.99)
(iv)	Grand total	481.91	
D.	Percentage of subsidies		
	To the Value of landings at landing centre	7.48	
	To the Value of landings at retail centre	9.85	

- Fishery subsidies greatly impact the sustainability of fishery resources. Subsidies that reduce the cost of fisheries operations and those that enhance revenues make fishing enterprises more profitable than they would be otherwise. The global fisheries subsidies are estimated at 30 billion dollars which comprises of good bad and ugly subsidies on account of their role in investment or disinvestment to the natural capital assets. The global subsidies are valued at 35–40 per cent of the value of total fisheries production. Fuel accounts to more than 27.7 per cent. The good subsidies account to 27 per cent of the total subsidy in terms of fisheries management, research and conservation programmes. Developed countries account for more than 68 per cent of subsidies, and developing countries the remaining 32 per cent. However on a per country basis, developed countries provide more than three times as much subsidy as developing countries.
- In the context of India the amount of subsidies provided is much less with less than 8 per cent of the total value even though challenged internationally .The marine fisheries sector in India is a subsistence fishing and much different from the factory / commercial fishing of developed countries. In addition the fuel subsidy provided contributes to less than 5 per cent of the total value of landings. But on the other side the welfare measures, saving cum relief, housing and other transfer payment adds to

the subsidy component in the Indian context. Further it is important that the good subsidies don't feature in Indian fisheries subsidy regime.

The different items of subsidy in the Indian fisheries sector (Centrally sponsored schemes) are as follows:

Table 10 : Subsidies in the fisheries sector in India (2010-11)

Items	Amount (Rs. lakhs)
1. Marine fisheries development	
a) Motorization of traditional crafts Central share (50 per cent): State share (50 per cent)	498
b) Rebate on HSD (central share-80 per cent state share 20 per cent)	936
2. Establishment of fishing harbours and other infrastructure	5282
3. Welfare measures	746
4. Institutes	4376
5. NFDB	8675
6. Aquaculture	2000
Total	22513

The various fishery development measures like motorization of crafts and rebate on HSD oil and fishing harbor development are included under the subsidy class of WTO as they directly promote fishing operations. The assistance for fishing harbor development is considered as an indirect subsidy in the WTO definition.

Table 11: Export subsidies (2010-11)

Export subsidies	Amount (Rs.lakhs)
Sea freight assistance scheme-for import of raw materials for preparation of value added products	
Tuna long lining	100.00
Development of potential farming area	679.00
Organic aquaculture	14.19
Digital data base on aqua farms	37.00
Ornamental fish breeding	209.00
Subsidy for promotion of aqua culture	414.00

Acquisition of processing machinery	1200.00
Technology for up gradation of marine products	105.00
Basic facilities for chilled fish/tuna	148.00
Effluent treatment plant	18.00
Promotion of aquaculture societies	177.00
Labs for quality certification	21.33
Landing centres/ fishing harbours-ice making machines and chill rooms	300.00
PCR lab	40.68
Total	3463.20

NFDB also promotes fisheries through development of fishing harbours, assistance to fish markets and deep sea fishing. The total assistance for marine fisheries development was Rs.998 lakhs in 2010-11. The support to institutes like fishery survey of India, Central institute of fisheries nautical engineering, NIFPHATT, Central coastal engineering institute, integrated fisheries projects etc. are considered as favorable subsidies as they promote sustainable fishing practices. Export subsidies are provided through various export promotion schemes of MPEDA. The total export subsidies amounted to Rs. 34.63 crores in 2010-11. The expenditure on subsidies for marine fisheries development, infrastructure and post-harvest operations declined from 60.85 crores in 2005-06 to 41.49 crores in 2007-08 and then increased to 62.8 crores in 2010-11. The total amount of subsidies to fisheries sector is 259 crores only which is less than one per cent of the fisheries GDP in India.

Figure 34. Growth in subsidies in marine fisheries development, infrastructure and post-harvest operations

Table 12 : Subsidies in Indian marine fisheries sector

Sl.No:	Parameters	2010	2011
1.	Marine fish landings in India (Qty)	3.32	3.40
2.	Value of marine landings at landing centre- crores	22,648	24,372
3.	Value of marine landings at retail level- crores	36,964	38,152
4.	Total subsidy	1927	1754
5.	Percentage of subsidies	8.51	7.19
6.	Subsidy per tonne of fish (Rs)	5806	5150

The implications on the study of subsidies indicated the following

- The amount of subsidies provided is much less with less than 8 per cent of the total value even though challenged internationally.
- The marine fisheries sector in India is subsistence fishing and much different from the factory / commercial fishing of developed countries.
- In addition the fuel subsidy provided contributes to less than 5 per cent of the total value of landings.
- But on the other side the welfare measures, saving cum relief, housing and other transfer payment adds to the subsidy component in the Indian context.

F. Trade and Resources

The relationship between the landings, export, CPUE were estimated and depicted graphically in the following figures. During 1985-2010, the marine products export has been increasing proportionate to the marine fish landings. The share of export has steeply increased from 2001 onwards compared to the previous period.

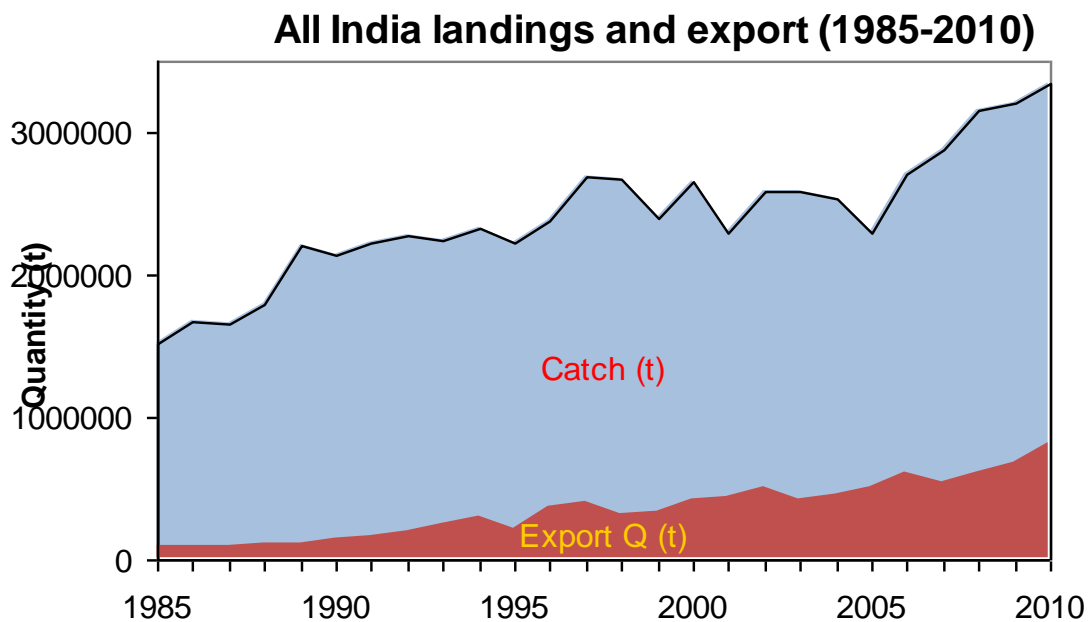


Fig. 4: All India landings and export (1985-2010)

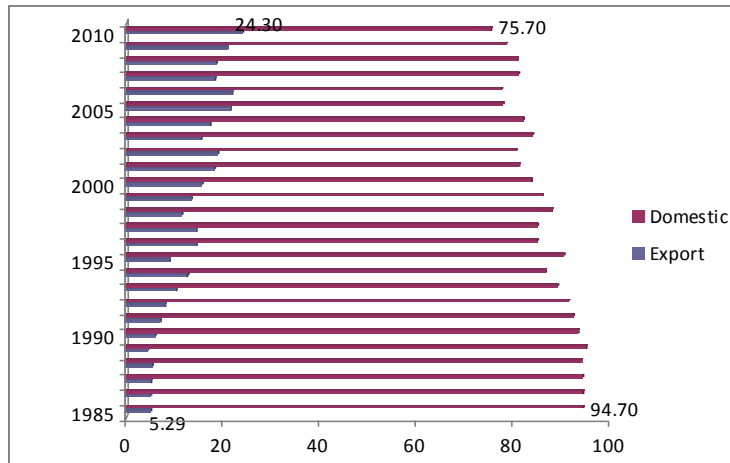


Fig. 5 : Share of landings to Domestic and Export market (1985 – 2010)
 There is positive relationship between quantity exported with that of total CPUE of the vessels. Whenever a landing increases, the CPUE also increases logarithmically.

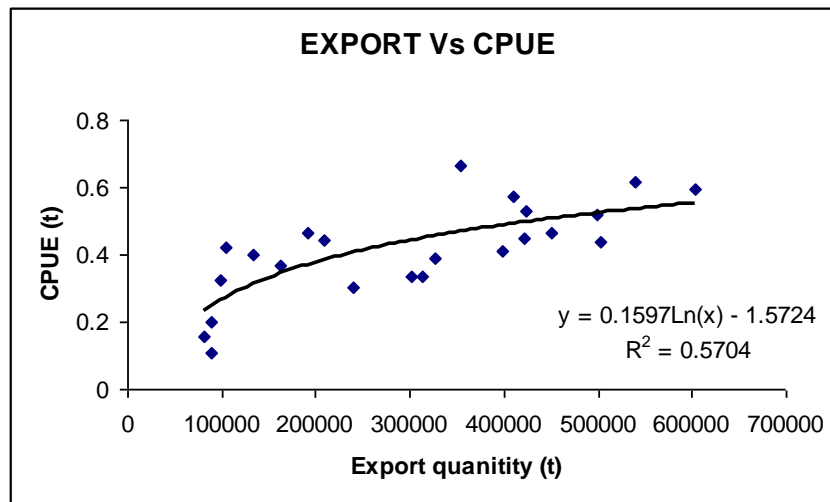


Fig. 6 : Exports vs CPUE

There is a steep increase in CPUE of mechanized vessels of India with the increase in export quantity (Fig.). However, the CPH of mechanized vessels showed a decreasing trend with increase in quantity exported (Fig.). This can be attributed to the induction of more number of multiday mechanized vessels to target the key resources of high demand in export market, which in turn reduced the CPH of vessels.

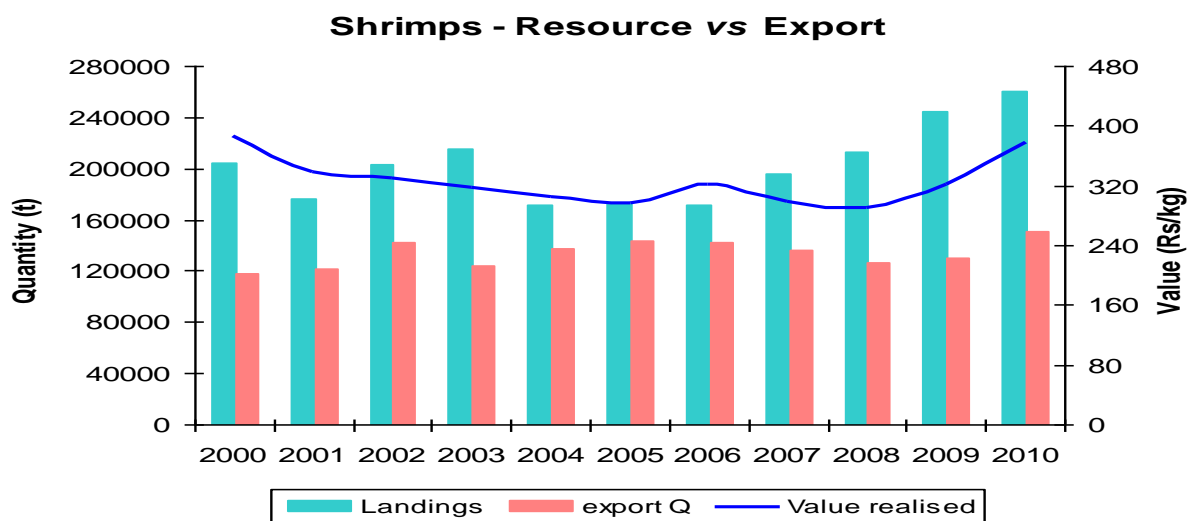


Fig. 7: Shrimps- Resource vs Export 1985-2010

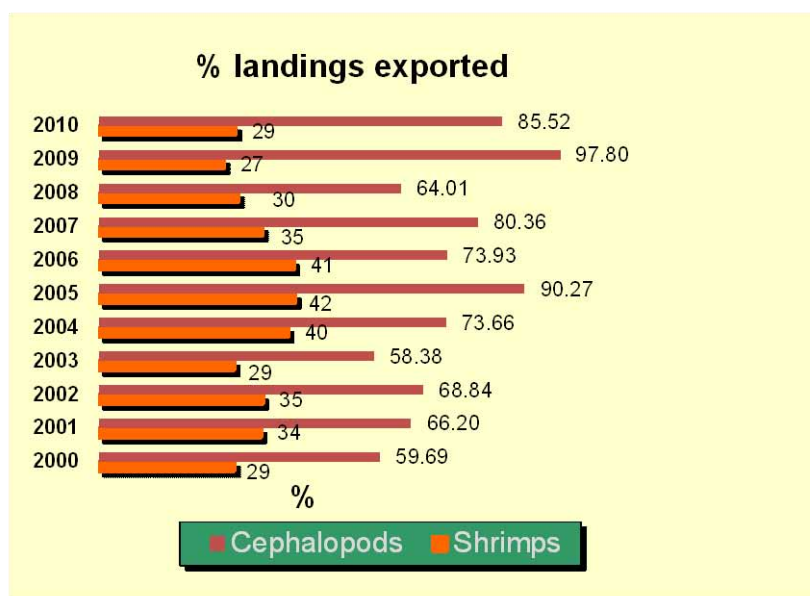


Fig. 8 : Percentage of landings exported 1985-2010

The value realized for shrimps during the last decade decreased with increase in landings. In the case of cephalopods, there is a marginal increase in the value with the increase in landings. This has resulted in the increase of per cent share of landings of cephalopods during the last five years.

Conclusions

Indian fisheries cannot escape from the stark reality of fierce competition emerging in the global scenario. Indian seafood industry, by and large, still remains as a supplier of raw materials to the preprocessors in foreign countries and 90 per cent goes in bulk packs, which is the prime reason for the drastic reduction in the unit value realization. Restrictions and levies imposed by both the exporting and importing nations acts as fiscal controls and hamper exports. The policy constraints often take the form of non- tariff barriers and generally relate to quality specification of the traded goods and also packing materials. India has taken a position that arbitrary as well as restrictive sanitary and phyto-sanitary measures continue to represent a major obstacle to international trade of agricultural products. Developing-country exports are usually affected because the Sanitary and Phyto Sanitary (SPS) measures are often developed in a non-transparent manner and developing countries invariably do not get adequate opportunity to respond to the proposed measures. A number of international standards are thus being developed without the participation of developing countries. As a result, standards are often being adopted without taking into account the problems and constraints that developing countries face. The export to the European Union still poses serious threats due to the quality aspects raised by the importers and the characteristics of a buyer market. Recently there had been reports of rejections of consignments from the European Union due to the detection of antibiotic microbial and bacterial residues to the tune of 500-600 crores annually. The overall production from export-oriented aquaculture during last year was estimated to be 1.33 lakh tonnes, which was a fall by 41,000 tonnes in quantity and Rs 941 crore in value compared to the previous year. Shrimp production showed a decrease by 26 per cent and scampi production by nine per cent over the previous year. Disease outbreaks and natural calamities were reportedly the prime reasons for the shortfall in aquaculture production. In addition to all these the recent economic slowdown and recession for the last three quarters is for sure take a toll in the balance of payment in the country. Depreciating rupee notwithstanding, global economic turmoil has started taking a toll on the country's robust export growth story.

Assessment of harvest and post-harvest losses in Fisheries

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Cochin - 29

Introduction

Fisheries provides livelihood for millions of people and valuable foreign exchange earnings to many countries. In India, the gross revenue at the point of first sales was estimated as Rs.20000 crores (ICAR, 2011) whereas at the point of last sales it was more than Rs.28000 crores. The current volume of marine product exports from India (2012-13) stand at 9.28 lakh tonnes valued at 3512 US million dollars.

Fish, requires proper handling, processing and distribution if it is to be utilized in a cost effective and efficient way. Unlike agricultural commodities, fish reaches the end consumer through a chain of distributors and the highly perishable nature of the commodity leads to appreciable loss due to various reasons at each stage. Losses occur in marine fisheries due to discards in good condition and spoilage makes it unavailable and unacceptable for human consumption. Global demand for fish is growing and reduction in post-harvest losses can make a major contribution to satisfying this demand, improving quality and quantity for consumers and increasing income for producers.

Losses in Marine Fisheries

There can be many definitions of losses. In the present context of this lecture, quantity of fish not suitable for human consumption due to physical loss or spoilage or some other reason is taken as loss. There are mainly two kinds of losses -harvest and post harvest losses. Harvest losses occur onboard the fishing crafts mainly in the form of discards of juveniles and low value fish and post harvest losses occur due to improper handling and lack of infrastructure at different points starting from the landing centre to the consumer. Apart from these, there are latent losses such as realization of low value due to glut, multi-day fishing etc.

Discarding takes place because, in the course of fishing, many species other than the target species are often caught. This by-catch is usually discarded at sea unless it is worth keeping. Discarding by-catch consisting of a small proportion of mature specimens from healthy stocks causes relatively little damage, but when it consists of juveniles of commercial species it will disturb the balance of the system. Catching large numbers of juveniles is likely to reduce the future number of mature fish. This will have a direct impact on the fishery taking the by-catch, or on other fisheries if the juveniles belong to their target species.

Apart from the loss of a massive amount of potentially valuable food, the incidental capture of dolphins in tuna purse seine nets, turtles in shrimp trawls and marine mammals, birds, turtles and fish in high-seas squid driftnets has led to widespread public concern. Unfortunately, by-catches are an inevitable consequence of an industry that depends upon the capture of species that live alongside other creatures in an opaque medium and as a result can seldom be directly observed and targeted.

By-catch arises primarily because of fishing gears and adopting practices which do not selectively target the desired size and species. The reason for discarding part of the catch is generally economic. In such cases the cost of bringing fish to market is greater than its market value and it gets dumped at sea. Similarly, where a fishing vessel has limited holding capacity, low-value species are discarded in favour of the high-value ones.

Introduction of improved harvesting methods, starting from mechanisation, indiscriminate increase in fleet size and number, multi-day fishing, use of unregulated mesh sizes have all led to imbalance in several forms and threatening of food security. In tropical countries, high temperatures lead to fish spoilage while still in the boat, at landing, during storage or processing, on the way to market and while waiting to be sold. There is also considerable economic loss as value gets lost because of lower quality, including insect infestation and breakage.

An assessment of the quantity lost due to harvest and post-harvest activities will help devise ways for maximum utilization at each stage of the chain of distribution of fish. Also it is essential to have an estimate of the actual economic loss that has occurred. Seasonal employment of different gears for fishing, duration of the fishing trip and glut also plays an important role in determining the price of the catch. Therefore an economic evaluation of the latent losses occurring due to harvest activities will be of interest.

REVIEW OF LITERATURE

Several studies have been conducted in the recent past for the assessment of extent of harvest and post-harvest losses in fisheries. As early as 1981 FAO recommended action to reduce post harvest losses in marine fisheries- estimated at that time to be 10 percent of the global total, and up to 40 percent in some developing countries.

Studies were conducted at CIFT, Cochin on 'Assessment of harvest and post-harvest losses in fisheries' through a NATP funded project. The percentage loss due to harvest through traditional, motorized, mechanized and large trawlers has been put at 4.13, 3.61, 14.48 and 21.41 respectively within the craft/gear (Anon., 2005). The study has also assessed post-

harvest losses in fisheries in different channels viz., market, pre-processing and processing and reported the percentage loss through each of these channels.

Raju (2010) has reported landing and discards at sea from ten coastal states of India including illegal and unreported landings. Kumolu-Johnson and Ndimela (2011) argue that losses can be physical, economical and nutritional and advocates suitable post-harvest technology for minimization of losses.

Ahmed (2008) has assessed post-harvest losses of fish in Sudan with special emphasis on cultural and socioeconomic aspects including traditional food conservation; economic factors for food conservation and cost-benefit; assessment of the effect of globalization and liberalization of food markets and the fish trade in artisanal fisheries.

Cawthorn, *et. al.* (2000) estimated post-harvest losses In North America at 10-15%, representing an economic impact of US \$50-75 million annually. Ward, A. (1996) developed methods to quantitatively assess post harvest fish losses and to understand and identify the causes in qualitative sense. Adams, (1995) advocates Individual Fishing Quota (IFQ) system where fishermen can be selective about factors as fishing depth, bottom substrate, or time of day, month or year. These factors are directly related to incidental halibut by catch mortality.

Clucas, *et. al.* (1989) reported 20% post harvest losses of annual fish production of about 13.5 lakh tonnes by 16 ECOWAS countries of West Africa. Similar figures were observed in the artisanal fisheries sector that contributes about 90% of the total catch.

Estimation of losses in fisheries

A recent study completed at CIFT, Cochin attempted to estimate harvest and post-harvest losses in marine fisheries. Ernakulam and Alleppey districts were covered for the study. The estimation was carried out at the two stages harvest and post-harvest stages using stratified random sampling design. The channels of fish production namely mechanised, motorised and traditional formed the various strata at the harvest stage, In the post harvest stage, losses occurring at landing centre, processing, marketing and transportation sectors were observed. The study was conducted for a full fishing season to observe loss pattern during monsoon, pre-monsoon and post-monsoon seasons. Around 1 to 3% sampling was done in the harvest stage whereas for the post-harvest study, the sampling done was from 10 to 30% for the various channels.

In the processing channel, the pre-processing centres and fish processing centres in Ernakulam and Alleppey district were covered by using of a sample. The losses occurring in marketing sector was studied in the wholesale markets, retail markets, roadside markets were covered for the study. The dryfish production and marketing channel was also studied by means of a sample for recording losses occurring in the dryfish sector. The estimates were computed using methodology derived by IASRI for loss estimation (Anon., 2005).

Harvest losses in marine fisheries was estimated from Ernakulam district by stratifying fishing crafts into mechanized, motorized and traditional. Primary data on fish catch and losses was collected for 12 months from fishing crafts operating in six selected fish landing centres at Ernakulam. Loss estimates were computed analyzing the season wise data and pooled data. The sector wise harvest loss estimates are as under :

Table 1: Harvest losses in marine fisheries

Sector	Pre-monsoon (%)	Post-monsoon (%)	Monsoon (%)	Overall (%)
Traditional	1.93 (0.43)	0.98 (0.37)	0.83 (0.28)	1.14 (0.28)
Motorised	3.45 (0.54)	2.76 (0.13)	4.38 (0.53)	3.65 (0.17)
Mechanised (upto 7 days fishing duration)	12.74 (1.23)	11.09 (0.11)	9.11 (0.05)	14.15 (2.10)
Mechanised (more than 7 days)	13.78 (1.24)	14.98 (1.35)	13.35 (1.32)	18.73 (2.22)

Multiday fishing by the mechanized trawlers reported maximum loss due to capture of juveniles and their discards. Around 1500 to 2750 kg of fish gets discarded at sea by trawlers during fishing trips for more than 7 days duration. The no. of hauls during fishing and loss was positively correlated (0.69) at 5% level of significance. The estimate of loss due to mechanized fishing was computed by utilizing information on no. of hauls which was more precise than the traditional estimator. The losses due to motorized fishing crafts was very less in comparison with trawlers. The traditional fisheries sector reported minimal or no loss during the period.

Post-harvest losses

Table 1: The post-harvest losses in marine fisheries (at the landing centre level) was estimated as below :

Sector	Loss % (SE)
Traditional	0.09 (0.0004)
Motorised	1.19 (0.07)
Mechanised	4.79 (1.09)

The loss estimates when compared with the estimates brought out by earlier studies indicate that the post-harvest losses have come down due to efficient handling of catch. The post-harvest losses in processing and marketing sector was also computed from Ernakulam-Alleppey during the period under report. For reporting loss in processing sector, 50 pre-processing units and 25 processing units were observed and data on raw material processed and loss were recorded fortnightly. Shortage of ice and spoilage were cited as the reasons for loss in pre-processing. At the processing stage, losses occurred due to discolouration, broken tentacles, black spot and at time loss during glazing. Few units reported rejections at export destination due to heavy metal detection.

Losses in the marketing sector was due to damage during transportation, spoilage when delay in transport and weather. Two wholesale markets for fresh fish and one wholesale market for dry fish were covered fortnightly for recording losses due to marketing. Similarly 4 retail markets were surveyed fortnightly of reporting loss in retailing fish. The estimates for post-harvest losses due in processing and marketing are given below :

Table 3 : Post-harvest losses in marine fisheries

Sector	Loss % (SE)
Pre-processing	0.38 (0.04)
Processing	1.19 (0.07)
Dry fish production	36.97 (12.88)
Wholesale market (fresh)	3.79 (1.09)
Wholesale market (Dry)	7.56 (2.12)
Retail market (fresh)	3.13 (0.02)
Retail market (Dry)	8.23 (0.13)
Roadside market (fresh)	2.54 (0.11)
Roadside market (dry)	5.43 (1.19)

The reasons for losses were also recorded along with the loss details. Harvest losses were mainly due to :

- i) Fish fall from net
- ii) Bruising due to handling
- iii) Fish spends too long in the net and gets spoiled
- iv) Lack of ice / Chilling causing spoilage

Post-harvest losses

At landing centre

- i) While loading for transport
- ii) Kept in the beach without sufficient ice

Processing level

- i) Low capacity of the plant to process
- ii) Adverse weather conditions (drying)
- iii) Insect infestation

Transport

- i) Mechanical damage
- ii) Delay in transport

Storage

- i) Poor storage
- ii) Insect infestation

Market level

- i) Insect infestation
- ii) Packaging
- iii) Mode of transport
- iv) Handling

Conclusion

A look at the loss estimates reveal that the fish loss in the mechanised fishing sector is more compared to the other sectors. Multi-day fishing leads to larger volume of discards at sea which has inflated the estimates. Use of stipulated mesh sizes to avoid juvenile fishing, use of by-catch reduction devices, utilisation of low value fishes for innovative product development and waste utilisation for production of fish based feed and manure will help reduction in harvest and post-harvest losses in fisheries. Training and awareness programmes on the responsible fishing methods developed by CIFT among the mechanised fishermen will check discards at sea. Under NAIP value chain project at CIFT, Cochin a number of innovative technologies for value addition from low value fishes were developed and demonstrated as viable business models for adoption by coastal fisherwomen. Popularisation of these technologies along the coastal belt will enhance the income and livelihood of the fisherfolk.

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Statistical tools /approaches in Behavioral Research

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Introduction

Statistics is the art of drawing conclusions about phenomena in which chance plays a role. The randomness may arise through a variety of reasons: the intrinsic random nature of a phenomenon, unavoidable noise in an experiment, conscious randomisation of experimental or measurement units, or as a best approximation to reality. The chance phenomena occur in a broad range of situations. This has rendered statistical science a highly multidisciplinary undertaking, but with a core body of concepts and methods that are common to the diverse applications. It is no exaggeration to say that all empirical research in the present day social and behavioural sciences relies predominantly on statistical analysis. There is a long-standing statistical tradition in educational and psychological testing (psychometrics), and also in survey research, marketing research and quantitative demographics (sociometrics). In this lecture different statistical tools/approaches in behavioural research are discussed.

Levels of measurement

Measurement is the assignment of numbers to objects or events in a systematic fashion. Four levels of measurement scales are commonly distinguished: nominal, ordinal, interval, and ratio. There is a relationship between the level of measurement and the appropriateness of various statistical procedures. For example, it would be silly to compute the mean of nominal measurements. However, the appropriateness of statistical analyses involving means for ordinal level data has been controversial. One position is that data must be measured on an interval or a ratio scale for the computation of means and other statistics to be valid. Therefore, if data are measured on an ordinal scale, the median but not the mean can serve as a measure of central tendency.

Things to give priority in conducting research

- Good development and/or review of constructs implicated in the research questions/hypotheses
- Well-argued theoretical framework and clear research questions/hypotheses (not null hypotheses –state your expectations clearly)
- Clear descriptions of all measurement and control processes
- Justification of your intended approaches for demonstrating measurement quality and for addressing your research questions/hypotheses
- Good discussion of, or testing of, measurement validity and reliability
- Conduct, discuss and appropriately revise measurement processes and general research procedures based on a pilot test on a small sample
- Appropriate handling of missing data and checking of assumptions required by statistical procedures to be applied (including any necessary transformations or other decisions about variables in the analyses)
- Use of statistical analyses, in appropriate ways, to address specific research questions
- Appropriate balance in reporting of descriptive statistics and tests of research questions/hypotheses using tables and figures
- Careful drawing of conclusions, being appropriately circumspect in how far you generalise from the data and/or infer cause-effect

Validity and reliability

For the statistical consultant working with social science researchers the estimation of reliability and validity is a task frequently encountered. Measurement issues differ in the social sciences in that they are related to the quantification of abstract, intangible and unobservable constructs. In many instances, then, the meaning of quantities is only inferred. Validity is the extent to which a test measures what it is supposed to measure. Research requires dependable measurement. Measurements are reliable to the extent that they are repeatable and that any random influence which tends to make measurements different from occasion to occasion or circumstance to circumstance is a source of measurement error. Reliability is the degree to which a test consistently measures whatever it measures. Errors of measurement that affect reliability are random errors and errors of measurement that affect validity are systematic or constant errors. It is important to bear in mind that validity and reliability are not an all or none issue but a matter of degree.

Sociologists use the following methods for collecting data

- Surveys
- Experiments
- Participant observations

- Secondary Analysis

The Steps in a Survey Project

1. Establish the goals of the project - What you want to learn
2. Determine your sample - Whom you will interview
3. Choose interviewing methodology - How you will interview
4. Create your questionnaire - What you will ask
5. Pre-test the questionnaire, if practical - Test the questions
6. Conduct interviews and enter data - Ask the questions
7. Analyze the data - Produce the reports

Significance in Statistics & Surveys

"Significance level" is a misleading term that many researchers do not fully understand. In normal English, "significant" means important, while in Statistics **"significant" means probably true** (not due to chance). A research finding may be true without being important. When statisticians say a result is "highly significant" they mean it is very probably true. They do not (necessarily) mean it is highly important. Take a look at the table below. The chi-squares at the bottom of the table show two rows of numbers. The top row numbers of 0.07 and 24.4 are the chi square statistics themselves. The second row contains values .795 and .001. These are the significance levels and are explained following the table.

Fishery Management Decisions: Solutions using Computing tools

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Fisheries management is in the domain of political affairs, integrating social, economical and ecological factors to select an appropriate management plan. It relies on stock assessment to get an idea about the current stock status and the consequences of alternative harvest levels. The advances in the quantitative fishery management in the last thirty years are driven by the theoretical and analytical techniques in general. The progress was possible specifically by the development and availability of computers, programming languages and computational algorithms. The fishery surveys, satellite remote sensing, continuous ecosystem monitoring, large-scale sensor networks, digital imaging, fish genomes etc., have generated massive data and computational requirements continued to increase and it resulted in development of many computing environments. The computing tools for fishery management has advanced considerably starting with the classical programming languages (BASIC, FORTRAN, C, C++, Pascal, APL, Python, Visual Basic etc.) to development of spreadsheets (Lotus 123, Microsoft Excel), comprehensive statistical packages (SYSTAT, Minitab, SAS, SPSS, GAUSS, S-PLUS, R etc.) and customized stock assessment software (ADMB, WinBUGS, OpenBUGS, Stock Synthesis 2 (SS2), CASAL, Coleraine etc.). This lecture note will take a look at some of the computing frameworks which are used among fishery scientists and managers.

ARTFISH

ARTFISH stands for Approaches, Rules and Techniques for Fisheries statistical monitoring and this is a standardized tool adaptable to most fisheries in the developing countries. Its design was driven by the need to provide users with robust, user-friendly and error-free approaches with computer software, and achieve the implementation of cost-effective fishery statistical systems with minimal external assistance. The ARTFISH outputs consist of documents, guidelines, manuals, case studies, training kits and computer software. Its components are ARTBASIC for handling sample data and producing monthly

estimates and ARTSER for the integration of monthly estimates into annual databases. The basic variables involve catch, effort, CPUE, prices, values and average fish size. ARTFISH utilizes technology that increases user cognition and decreases training time. It also provides detailed statistical diagnostics on data quality and allows insights into the fisheries for which the data is being collected.

BEAM1 and 2 - Bioeconomic modeling of artisanal and industrial sequential shrimp fisheries

BEAM 1 and 2 are developed for bioeconomic modeling of artisanal and industrial sequential shrimp fisheries based on an age-structured Thompson and Bell yield per recruit model and a simple input-output microeconomic model. BEAM1 gives its simulated results by age groups. BEAM2 gives them by standard commercial categories as used in the shrimp fishing industry. The user interface of the program is like a spreadsheet which allows the users to simulate interactively various management options, changing the number of recruits, the size of the fishing fleets, the fishing regime (i.e., the age at first capture in the two sequential fisheries) and the economic parameters of the fleets and of the processing sector. The programs give their results in terms of biomass and catch, in numbers, weight and value.

BEAM4 - Analytical Bioeconomic Simulation of Space structured Multispecies and Multifleets Fisheries

BEAM4 (BioEconomic Analytical Model) is a software designed to predict yield, value and a series of measures of economic performance as a function of fishery management measures such as fishing effort control, closed season, closed areas and minimum mesh size regulation. It is a versatile tool for the rational management of exploited living aquatic resources. It can deal with a fishery system of several stocks, several fleets, several fishing grounds and several processing plants and can account for migration of the animals as well as seasonality of recruitment. BEAM4 depends on an age structured cohort based fish stock assessment model combined with an economic model of both harvesting and processing sectors. The measures of economic performance calculated by the economic submodel include private profit, profitability, gross value added, net value added, national net value added, resource rent, employment, costs in foreign exchange and foreign exchange earnings. Though BEAM4 was primarily designed for the analysis of tropical mixed fisheries with penaeid shrimps as the target and finfish as the by catch, it can be used to analyze any fishery. Also, it is suitable for the analysis of resources shared between artisanal and industrial fisheries.

CLIMPROD

CLIMPROD is designed to fit surplus production models using catch and effort data as well as including environmental variable into the model. CLIMPROD requires annual dataseries on catch and effort of a fishery on a single stock, and annual (or seasonal) data series on an environmental variable known to influence the abundance or the catchability of this stock. At least 12 years observations are required. The software offers a statistical and

graphical description of the dataset and then allows an appropriate model to be chosen, fitting it using a nonlinear regression routine and trying to assess the fit with parametric and nonparametric tests before presenting the tables and graphs of the results. These results may explain how environment and fishing effort governed the yields of the fishery during the period under study. Based on an estimate of the next two years' data on effort and environmental regime, an exploratory prediction is proposed for catches per unit of effort (CPUE), and a graph gives variations in "maximum sustainable yields (MSY)" and "optimal fishing efforts (fmax)" according to different environmental regimes.

FAST

The Fishing Activity Simulation Tool, called FAST has been developed as an extension for the ESRI ArcView GIS Software (v.3.1) in combination with the Spatial Analyst v. 1.0 extension. It is based on two models, one of them based on the concept called 'friction of distance' and the other one based on a deductive model on the use of space. Both models are developed in FAST giving values to a set of variables taking part in the spatial distribution of effort ('scoring function'). These values are distributed as percentage of the total effort exerted for every variable considered.

FiSAT

The FAO-ICLARM Stock Assessment Tools (FiSAT) is a package consisting of robust methodologies to formulate management options for fisheries, especially in data-sparse, tropical contexts. FiSAT is resulted from merging of LFSA (Length based Fish Stock Assessment) developed at FAO and the ELEFAN (Electronic Length Frequency Analysis) package developed at ICLARM.

FishStatJ

FishStatJ provides users with access to Fishery Statistics of various sorts. Any data having time series structure can potentially be stored and processed by FishStatJ. The system consists of a main module and the datasets. Currently one set of data is included within the set up module, while other sets are provided separately.

NANSIS

NANSIS is a software for Fishery Survey Data Logging and Analysis. This is a Survey Information System for logging, editing and analysis of scientific trawl survey data (trawl/catch data and length/frequency data).

SPATIAL - Space time Dynamics in Marine Fisheries

SPATIAL is a simulation package developed to model the space-time distribution of fishing intensity using alternative approaches. Three models were built with different input data requirements and output possibilities. ALLOC is a shortrun spatial bioeconomic model that represents the interdependencies of smallscale and industrial fleets from different ports of origin, harvesting a target species over several fishing grounds. Model YAREA

introduces geographically contiguous unit areas, and the realism of age structure. It generates a virgin stock by stochastic patch distribution of recruitment, constrained by a user provided maximum species biomass spatially distributed in the corresponding grid. Model CHART was designed to represent the short and longrun spatial dynamics of demersal fisheries as a result of interacting biological, economic, and geographic characteristics. It is an age structured model like YAREA, but incorporates distance from different ports of origin and the shortrun bioeconomic elements of ALLOC. The location of fishing sites are specified in geographic coordinates. When data are available, CHART seems to provide the most comprehensive representation of the space-time distribution of fishing intensity.

Ecopath with Ecosim (EwE) is a free ecological/ecosystem modeling software suite. EwE has three main components: *Ecopath* - a static, mass-balanced snapshot of the system; *Ecosim* - a time dynamic simulation module for policy exploration; and *Ecospace* - a spatial and temporal dynamic module primarily designed for exploring impact and placement of protected areas. The Ecopath software package can be used to Address ecological questions; Evaluate ecosystem effects of fishing; Explore management policy options; Analyze impact and placement of marine protected areas; Predict movement and accumulation of contaminants and tracers (Ecotracer); Model effect of environmental changes.



LFDA

The Length Frequency Distribution Analysis (LFDA) package is designed for estimating growth parameters and mortality rates from fish length frequency distributions. LFDA includes methods for estimating the parameters of both non-seasonal and seasonal versions of the von Bertalanffy growth curve. The package includes Shepherd's Length Composition Analysis (SLCA) method, the projection matrix (PROJMAT) method, and a version of the Elefan method for estimating growth parameters. In addition to methods for estimating growth parameters, the package also includes three methods for estimating the total mortality rate, given estimates of the von Bertalanffy parameters. A function allowing simulation of length frequency data under a variety of assumptions is also included.

CEDA

The Catch Effort Data Analysis package (CEDA) is for analysing catch, effort and abundance index data. CEDA allows calculation of estimates of current and unexploited stock sizes, catchability and associated population dynamics parameters. Both depletion and several types of stock production (biomass dynamic) models can be fitted, using one of three

different assumptions about the distribution of residuals. Both point estimates and bootstrap confidence intervals for the estimated parameters can be calculated. CEDA also includes the facility to do projections of stock size into the future under various scenarios of catch or effort levels, so that different management strategies can be investigated.

Yield

Yield is a program for calculating fishery yields and stock biomasses, on an absolute or per-recruit basis, and for calculating biological reference points associated with these. On starting the program, users are asked to enter values of biological parameters (e.g. growth, mortality, age at maturity and stock-recruitment relationship) and fishery parameters (e.g. length at first capture, fishing season). For each parameter, either a single value can be entered, or a probability distribution can be specified to allow for uncertainty. When calculating yields and yields per recruit, the program takes explicit account of specified parameter uncertainties, presenting results in terms of histograms. Transient projection and reference point calculations can also be made, once the extent of stochastic recruitment variability has been specified

ParFish

Participatory Fisheries Stock Assessment (ParFish) Software uses Bayesian Statistics and Decision Theory to assess the state of a fishery stock and estimate limit and target control levels. The ParFish software is based on the logistical biomass growth model and requires information on four parameters: Current Biomass, Unexploited Biomass, Catchability and Growth rate. Interview data from fishers are used to construct 'priors' for the model parameters which can be combined with other available information to provide best estimates. This information is then used, together with preference data from fishermen, to calculate the current stock level and the control levels that will provide the most preferred catch rates for fishers. The programme takes explicit account of uncertainty in the data, presenting results as probability density functions.



SAS

The SAS System provides a powerful framework for statistical analysis. In addition to statistical analysis, it also allows programmers to perform report writing, graphics, business planning, forecasting, quality improvement, project management, and more. SAS is a good program for the intermediate and advanced user because it is very powerful, can be used with extremely large data sets, and can perform complex and advanced analyses. SAS is run largely by programming syntax rather than point-and-click menus, so some knowledge of the programming language is required. For a new user, learning how to write code and run the appropriate procedures can be daunting. Enterprise Guide enables you to get answers without having to write programs, through a point-and-click interface making selections from a series of menus. As a benefit even for experienced SAS programmers, EG provides a framework within which to organize the data, tasks, and results involved in

performing a statistical analysis, through the creation and maintenance of “projects”. The web site at <http://www.sas.com/>, gives complete information about SAS. SAS is fully supported on Windows and on UNIX/Linux, and is fully up to date on these two operating systems.

IBM SPSS Statistics

SPSS, is the one among the popular data management and analysis product used in various fields of research. Originally named Statistical Package for the Social Sciences, later modified to Statistical Product and Service Solutions to reflect the diversity of the userbase. Now it is acquired by IBM in 2009, and current versions are officially named IBM SPSS Statistics. Companion products in the same family are used for survey authoring and deployment (IBM SPSS Data Collection), data mining (IBM SPSS Modeler), text analytics, and collaboration and deployment (batch and automated scoring services). The IBM SPSS Statistics offers the core statistical procedures which business managers and analysts need to address fundamental business and research questions. The software provides tools that allow users to quickly view data, formulate hypotheses for additional testing, and carry out procedures to clarify relationships between variables, create clusters, identify trends and make predictions.



STATA

Stata is a full-featured statistical programming language that runs on a variety of platforms such as Windows, Mac OS X, Unix and Linux. It can be used for both simple and complex statistical analyses. STATA uses a point-and-click interface as well as command syntax, which makes it easy to use. STATA also make it easy to generate graphs and plots of data and results. Analysis in STATA is centered around four windows: the command window, the review window, the result window, and the variable window. Analysis commands are entered into the command window and the review window records those commands. The variables window lists the variables that are available in the current data set along with the variable labels, and the results window is where the results appear.



The following are packages developed using R computing framework which are useful for performing specific fisheries related analyses.

FSA: Fisheries Stock Assessment

A wide variety of functions used to perform traditional stock assessment methods – e.g., population, growth, mortality, etc. estimates. Also includes functions for visualizing the effect of violating assumptions in common stock assessment models. Originally developed as a teaching tool, FSA has been expanded to be a useful analytical tool.

FLR: Fisheries Library in R

A collection of tools in the R statistical language that facilitates the construction of bio-economic simulation models of fisheries and ecological systems. It is a generic toolbox, but is specifically suited for the construction of simulation models for the evaluation of fisheries management strategies. The FLR library is under development by researchers across a number of laboratories and universities in various countries.

Fishmethods: Fisheries Methods and Models in R

Fishmethods is a comprehensive collection of functions written in R to perform fishery methods and models from Quinn and Deriso (1999), Haddon (2001), and the literature.

ADMB - Automatic Differentiation Model Builder

ADMB-based computer models are used globally to monitor populations of many endangered and commercially valuable species, to develop place-based resource management policies, and to reconstruct movements of animals tracked with electronic tags. ADMB-based stock assessments are critical to the management of commercially important fisheries stocks.





Responsible Fisheries Management: ICT Perspective

Information Communication Technologies for Sustainable Management of Natural Resources: Principles, Practices and Applications

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Introduction

Deterioration and depletion of natural resources have become key concerns of our times and are being attributed to a resource intensive development paradigm. As the thrust on natural resources becomes heavier day by day, we are cautioned of indiscriminate exploitation and uncontrolled consumption and the several consequent perils in the offing (Hardin, 1968; Tongia et al 2005, Ostrom, 2011). The major concerns include climate change, depletion of biotic and abiotic resources, loss of biodiversity and ozone layer depletion. There are also issues such as land degradation, deforestation and diminishing water resources to cite a few, that impact life of the people directly. Being a matter of tremendous global importance which has found a place in the UN's millennium development goals, multi faceted efforts to seek remedies to these problems are actively on. As evinced by the global deliberations and the multilateral agreements, the focus is mainly to avoid ecological disasters through diplomatic cooperation among nations and by helping individuals and communities optimally manage resource use and consumption. Nonetheless, undertaking this responsibility also implies matching of diverse interests and concerns of the various stakeholders in the complex web of transactions involved in it. There are innumerable dimensions to this problem and regulating the use of natural resources without affecting the livelihood options of the people who depend on it is indeed challenging.

The strategies to ensure sustainable management of natural resources involve several approaches and tools. They are multi disciplinary and multi level in nature, which would essentially include formulating regulatory policies, instituting mechanism for monitoring, enhancing capabilities of stake holder agencies, individuals and communities, and keeping vigil at the grassroots level. Needless to say, these interventions are information intensive and require careful management of data and information for efficient

planning, implementation and monitoring. This has necessitated employment of ICTs in this mammoth effort. Ranging from worldwide interventions to local level applications, ICTs for sustainable management of natural resources involve sophisticated information systems, remote sensing, maps, databases, simulation tools, educational tools etc. Several applications are in vogue to enable governments, organizations, community groups and individuals to intervene in sustainable natural resource management (NRM) efforts systematically and effectively. However, even while there are large number of applications, societal interface of these technologies is still in a stage too early to facilitate local level interventions.

As the nature and magnitude of issues vary, these applications may have to be customized according to specific conditions. There is immense scope to develop specialized applications to address these problems, taking into consideration the wide local variations in natural resources and the problems related to their conservation. For that matter, any technological intervention towards this objective will have to be grounded on the geographical and bio physical characteristics of the location and the socio economic attributes of the people, who are the major stakeholders. This in turn calls for context specific applications intended for broader outcomes and sustainable conservation goals with a long term perspective. Taking cues from the extensive literature on NRM practices with people at the centre, there is immense scope for developing ICT applications that envisage community participation, capacity building, establishing and maintaining institutions and providing information support to people's initiatives.

In the light of the above, we shall try to characterize the pre requisites of a people oriented ICT strategy for natural resource management at the grassroots level. It is attempted by analyzing the predominant theoretical tenets on community based natural resource management (NRM) and looking into the details of some widely known applications of ICTs for sustainable management of natural resources deployed at different parts of the world in different contexts. An overview of these applications in the light of the growing body of knowledge on community based NRM would perhaps help us formulate context specific ICT programmes for effective and long standing NRM. Though ICTs would surely provide us with the tools to support NRM interventions, it requires an understanding of the socio- economic and political context in which such efforts would unfurl to devise appropriate strategies for employing the tools and rolling out the programme.

Socio-political dimensions of NRM: Growing evidence on the importance of community based intervention

Managing natural resources is not as easy as it might appear, as the process has become too complex with the bludgeoning population, increasing demand on resources and the uneven grounds that make a large section of the population disadvantageous. However, it should not be forgotten that NRM fundamentally involves the approach to resource intensive development, which cannot be either halted all of a sudden or allowed to continue unbridled. There are several issues that remain to be tackled in this connection. One is the predominance of pro industrialization growth model pursued relentlessly by many

developing economies, in spite of the inherent perils of resource depletion and unsustainable practices. Secondly, this entails severe thrust on the livelihood options of indigenous and marginalized communities, which would again have its toll on development objectives. Community based NRM, therefore invariably throws up conflicting concerns and contradictory interests when it is discussed in relation to development. Striking a balance between these two seemingly disagreeing propositions make any intervention, including the application of ICTs difficult.

The context in which NRM strategies work shall be depicted as given in Fig.1. There are three broad levels of concerns: global, national/state and individual/community. The macro level issues involve climate change, resource depletion and the question of development, which also constitute the major framework for intervention at the lower levels. However, when it comes to the national level, it has implications on capital investment, which is a pre requisite of economic development and is greatly influenced by access to resources. It also involves socio economic disparity which is a function of several factors such as power equations, uneven distribution of resources, ownership of assets etc. Interestingly, this further implies economic prosperity at the grassroots level, which is dependent on access to resources for livelihood options and food security. The contradictory interests that have been mentioned earlier operate within this framework.

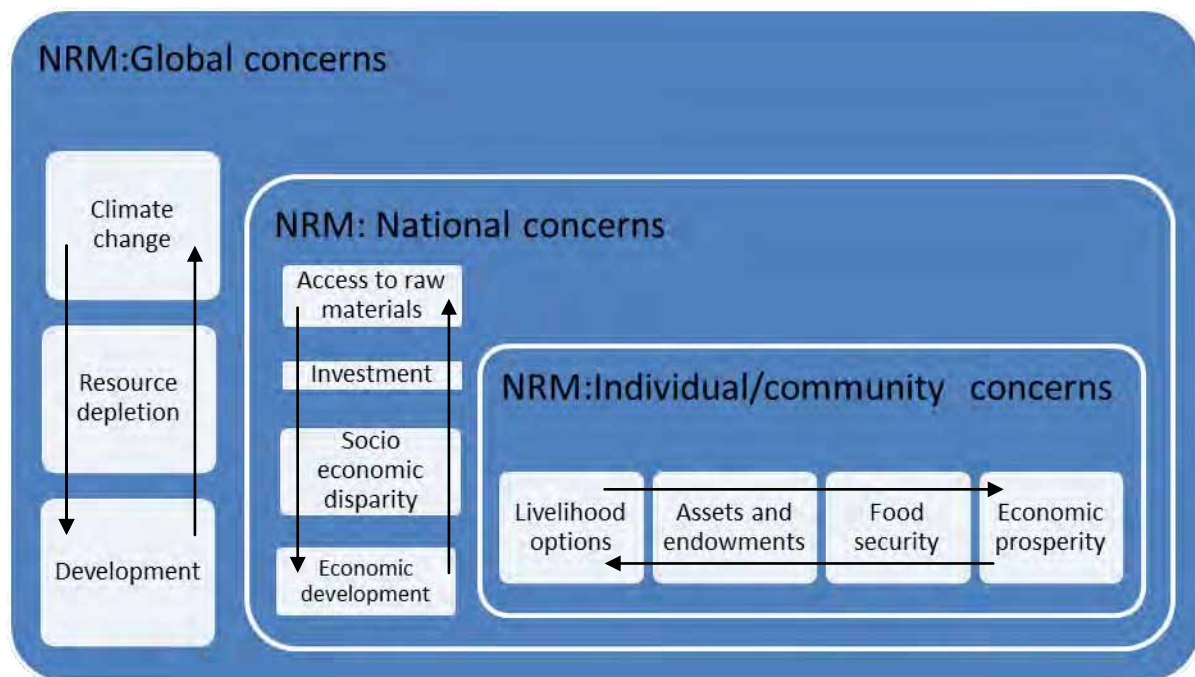


Figure1: Facilitating NRM: Concerns at different levels of intervention

It is in this milieu, intervention for natural resource management is considered to be more of socio- economic and political than technological in nature, particularly in developing economies. Managing resources is rather perceived as a social intervention involving multiple actors and processes. The extensive literature on natural resources and

properties of the commons agrees upon the significance of evolving new mechanisms of conservation by involving all possible stakeholders, resolving conflicts and promoting consensus.

Social dimensions of natural resource management has gained importance with the phenomenal contributions of Ellinor Ostrom, who argued for poly centric systems for conservation of natural resources and mitigating the possible threats of climate changeⁱ. According to her, even while the global policy is frequently posited as the only strategy needed, there could also be several positive actions underway at multiple, smaller scales to start the process of climate change mitigation and needless to say, conservation of natural resources. She emphasizes the need to understand the strength of polycentric systems where enterprises at multiple levels may complement each other. According to her, “Building a global regime is a necessity, but encouraging the emergence of a polycentric system starts the process of reducing greenhouse gas emissions and acts as a spur to international regimes to do their part”

Considering all the above, an ICT programme for sustainable NRM should be robust enough to provide the stakeholders at all levels with the huge information and data support required to enable realistic resource appraisal, optimal use of resources, efficient project administration, effective monitoring, wider networking and extensive awareness building. Though ICTs can be put to use in every dimension of NRM, designing and implementing a people centric programme require substantial consultation among stakeholders and careful consideration of the multitude of interests they possess.

Employing ICTs for NRM: Possibilities

Employing ICTs for NRM would require an examination of the nature of ICT applications that are currently used in the process. Leaving out the use of ICTs in the form of sophisticated equipments and programmes in research and commercial enterprises, application of these technologies directly at the grassroots level is alarmingly low in developing economies. Though there are several anecdotal references to successful ICT interventions in NRM, there are no comprehensive programmes that address issues of equity and sustainability. Observation by Jhunjhunwala and Aiyar (2006) that ‘only a few organisations in India have taken up ICT initiatives in any comprehensive manner and have tried to build services which can be scaled up and have a long-term sustainable impact on the society’ remains absolutely true for NRM.

The ways by which ICTs could be employed in NRM shall be summarized as below:

- Collecting data without physically visiting a place. For example, captured data, i.e. recorded digital data from remote sensing satellites or areal photographs would be of immense help in delineating geographical entities and assessing resources
- Interpretation of data captured or collected. Eg. Interpretation of data from remote sensing

- Record text, drawings, photographs, audio, video, process descriptions, and other information in digital formats. For example digitization of maps in different scales
- Creation of databases and information systems by employing Geographical Information System tools
- Transfer of data and information over a network
- Simulation of future scenarios by processing spatial and temporal data, using mathematical models
- Communication of useful information to the general public as well as stakeholders by providing greater interactivity in communicating, evaluating, producing and sharing useful information and knowledge
- Information systems for planning, implementation and monitoring of development interventions
- Databases that could be integrated at various levels
- E- governance applications for increasing efficiency and enhancing transparency of development agencies

Different contexts of NRM would require any one or a mix of several applications listed above. Most of these applications involve collection of data and tools for working with those data made available either in analog form or digital form about a phenomenon in the real world. Choosing the appropriate application demands objective evaluation of the situation, infrastructure facilities, economic feasibility of the technology, capability of the human resources to employ various tools, policy guidelines etc. A comprehensive ICT programme for sustainable NRM may have to integrate several of these applications to suit the situation under consideration. To be more precise, any ICT programme for NRM should primarily identify the intervention that can assist realization of information and communication needs of the community and find out whether there exist any effective linkages among different actors who would require the information. It should also find out how the nature of interactions among the actors affect the quality of information accessed by the beneficiaries of the programme. Most importantly, such initiatives should also be preceded by an objective assessment of the gaps in information.

ICT applications for NRM: A Global Review

Characteristics of an ICT programme for NRM as described earlier would be clearly understood from a review of ICT enabled NRM initiatives reported from different parts of the world. These are location specific or issue specific applications used by various actors, including government agencies, private agencies, NGOs, local governments etc.

Table 1 : ICT Programmes for sustainable NRM: A Global Review

Sl No	Name	Agency/Country	Intervention	Major Features
1	Application of	The Philippine	Conservation of ancestral	Participatory

SI No	Name	Agency/Country	Intervention	Major Features
	ICTs in land surveys and registration systems Participatory 3D mapping in the Philippines	Association For Intercultural Development (PAFID) - NGO that assists indigenous communities to regain and secure ancestral domains	domains	mapping and GIS integration
2	Global Fire Monitoring Centre (GFMC)	Joint FAO/UNECE/ILO Committee on Forest Technology, Management and Training	Disseminate core outputs of the Economic Commission for Europe (ECE) in the field of forest fires as well as the periodic online collection and publication of fire statistics of the member states, and online publication of the ECE/FAO Team of Specialists on Forest Fire. The fire statistics from all Western and Eastern European Countries are collected and evaluated by the UN-ECE Trade Division, Timber Section, Geneva.	Providing data to agencies and governments
3	Food Insecurity and Vulnerability Information and Mapping System for Asia (Asia FIVIMS)	FAO	Coordinates efforts to identify the most food insecure and vulnerable populations at sub-national level	Provide data/information support to countries to formulate targeted policies and programmes to improve the food security and nutritional status of affected population and livelihood groups
4	Logging Off - Malaysia	The Uma Bawang Residents' Association (UBRA) an indigenous community	UBRA uses participatory tools, such as mapping and modelling to represent land and the associated resources to reinforce	Mapping by communities Maps later digitized for formulating

Sl No	Name	Agency/Country	Intervention	Major Features
		The Borneo Project, Sahabat Alam Malaysia	bottom-up development and collective decision-making	community interventions
5	Hanoi Land Information Management	Canadian International Development Agency - CIDA, the University of Montreal, the City of Montreal and the City of Hanoi	A land information system (LIS) and a parallel training programme in Geographic Information Systems (GIS) for Hanoi, to improve the city's land management and urban planning practices	Developing geo referenced Information Systems for urban planning Transparent access to information
6	Mekong River Commission, South East Asia	Mekong River Commission, South East Asia	Aims at providing access to information about participatory natural resource management in Cambodia, Laos, Thailand and Vietnam. The platform is intended to contribute to the empowerment and the support of actors working in the region to share their experiences and joint efforts in further research and practices	Building information repository and providing access to various stakeholders for formulating action plans to manage river resources Facilitates the emergence of regional and sector knowledge networks and communities of practice
7	Environmental Information Circulation and Monitoring System on the internet	ITU (International Telecommunication Union, UNITAR and the Observatory for the Sahel and the Sahara (OSS)	Developing information heritage relating to the environment, improving access to and exchange of environmental information, creating synergies and coordinating environmental operators	Information System on Desertification (ISD) – Environmental Information Circulation and Monitoring System on the Internet (EISI) in Africa
8	Thailand Integrated Water Resource Management	Royal Development Projects Board in collaboration with the Suksapattana Foundation, and the Thailand Research	Developing an information system on water resources and promoting the linkage of information to improve management in terms of preventive measures and	Computerized information system on water resources Awareness creation

SI No	Name	Agency/Country	Intervention	Major Features
		Fund (TRF)	problem solving after disasters. The data is made publicly available or further developed to raise awareness among the people. Reducing the risks from floods and droughts directly minimizes financial losses	among people by using the output of the information system
9	Satellite-based Fishery Vessel Monitoring System in Mauritania	Gtz, Germany and Maritime Ministry, Mauritania	Manage the threatened fishery resources in the country's Exclusive Economic Zone (EEZ) in a sustainable manner.	A near real time satellite-based vessel monitoring system on top monitoring vessels, radar surveillance and fishery inspectors
10	UN Water Virtual Learning Centre	Asian Institute of Technology and the University of the South Pacific	Enhance local, national and basin-scale capacities for sustainable water management in the developing world	<p>Educational programme with a user friendly interactive curricula</p> <p>Resource databank containing copyright-free materials, public domain images, graphics, documents and databases. Electronically transcribed materials available online and offline</p>
11	Ocean Data and Information Network for the Central Indian Ocean region (ODINCINDIO)	UNESCO	Enhance marine research, exploitation and development by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products.	<p>ICTs for data management and dissemination</p> <p>Decentralized network of data centres accessible and searchable over the Internet instead of traditional model</p>

Sl No	Name	Agency/Country	Intervention	Major Features
			<p>Member States have established over 60 oceanographic data centres in as many countries</p> <p>Collect, control the quality of, and archive millions of ocean observation-physical oceanography, chemical, biological- and makes these available to Member States</p>	<p>of centralized data centres at national or global scale Enable easy access to data, data products and information by a wider range of user communities</p> <p>Capacity building through training</p>
12	Fund for Sustainable Biodiversity Management	Hivos & Partners, Africa	Contribute to the sustainable management of biodiversity in primary production processes that are accessible and beneficial for small scale producers	<p>Supports regional and global civil society organizations and networks that promote access to and sustainable use of biodiversity by marginalized sectors of society</p> <p>Database creation, Capacity building and funding</p>
13	National Animal Tracing Database - Switzerland	Swiss Confederation of Professional Associations	Website on animal health management commercial transaction	<p>Facilitate the every-day interactions with governmental administration services as well as with other organizations. Up-to date users information for relevant technologies is also posted on a regular.</p> <p>Helps know the history of a particular animal, round the clock through SMS</p>

Sl No	Name	Agency/Country	Intervention	Major Features
14	Internet-Linked Boats for Ecological Awareness - Bangladesh	Shidhulai Swanirvar Sangstha (SSS), Commonwealth of Learning	Reduce pesticide use, improve water quality, and increase incomes in isolated river basin farming communities through distance learning programs on water health and rights provided by Mobile Internet-Educational Unit Boats (MIEUB)	Address the water education needs of a large but commonly neglected population living in the deserted islands during floods and other disasters
15	RANET - Global		RANET is an international collaboration and partnerships at the community level in order to ensure that the networks it creates serve the entirety of community information needs. Community ownership and partnership is the core principle of RANET's sustainability strategy. to make weather, climate and related information more accessible to remote and resource poor populations. The program combines innovative technologies with appropriate applications	
16	New Zealand Ecological Restoration Network	NERN (NGO)	<p>Sharing knowledge and experiences about ecological restoration in New Zealand</p> <p>Provide communities with useful information on resources in the country</p> <p>Conduct awareness programmes by involving the community</p> <p>A web based tool for recording observations and receiving analysis to aid</p>	<p>On line resources on environment preservation and valorization</p> <p>Virtual arboreta (living collections of trees and shrubs in a parkland setting), BirdGuide (including list of bird species found in New Zealand, recording observations by locality as well as historical</p>

SI No	Name	Agency/Country	Intervention	Major Features
			more informed decision making	information about previous bird distribution), Bush Library (referring to books, magazines, articles, maps, downloads, videos, images related subject), Climate & Soil Directories and Land Resource Inventory

Sources: Brandl et al(2002), Gessa (2008), ITU (2012)

ICT strategy for natural resource management: Typology of ICT interventions

A critical look at the global programmes and similar other local level interventions show some distinct components that mark the current ICT interventions for NRM. Though many of them are based on data captured through satellite imagery and remote sensing, there are also interventions at the ground level involving communities. While general prescriptions regarding macro level interventions are possibly available from captured data, it is important to look into the mechanisms by which the stakeholders at the ground level make use of them. Interestingly, ICT programmes for sustainable NRM do not remain techno centric. Rather, the tools and approaches are chosen in response to the specific issues a certain beneficiary community or communities face. The programmes also include components of social action, which should go hand in hand with the technology oriented components. Given below is a typology of ICT interventions elicited from the review done above.

Observation: Monitoring natural resources and their use through satellite and human observation, and generating data archives. This is a key area where satellite technologies, remote sensing applications GIS, mapping , sensor technologies, in situ data collection and data mining are now used regularly. ICT enabled observation has become an integral part of natural resources management and monitoring.

Modeling and simulation: This involves computational, analysis, and processing tools. Satellite and aerial borne data together with in situ and other archived data is used for forecasting trends and /or scenario building to enable well informed decision making. Used in studies on climate change, resource depletion etc

Databases, data products and data services: Generate extensive as well as location specific databases either based on field level primary observations or with community participation. It includes digitization of existing legacy databases or generation of new databases based on

transactions. Since database creation incurs heavy cost, sharing databases among the members of a group is becoming popular.

Policy analysis & planning: This category includes Decision Support Systems and alert tools. These together with the above tools are the tools for intelligent decision making. Customized applications that would help organizations and policy makers derive useful conclusions while making decisions fall under this category

Socio-economic analysis: Monetary valuation tools and statistical tools. The impact of use or loss of natural resources is measured through various approaches. This has several applications in the context of benefit sharing related to common property resources and the eco services provided by natural resources.

Capacity building & cooperation: They include a wide variety of off line and online tools for e-learning. Creating active e- forum platforms, centres for data gathering and analysis are possible in every . There is immense possibility to develop innovative content on sustainable NRM for various users. Online and off line training programmes would help organizations, activists, government officials etc to learn the principles and practices of sustainable NRM.

Research and academic networking : This type of intervention is very important in facilitating academic research in the field of NRM, by sharing resources from across academic institutions and research organizations.

Monitoring grassroots level interventions: Community based Management Information Systems for assessing and recording resources and monitoring their use by stakeholders. This could be deployed in local self government institutions and would be helpful in planning conservation programmes.

Awareness building: Most of the applications are designed for the purpose of information sharing and knowledge management in the field of NRM. There are several online as well as offline resources that facilitate awareness building. Content development and management are the prominent activities involved in this type.

As understood from the global experiences reviewed above, the major components of a comprehensive ICT programme for sustainable NRM and their relationships can be delineated and represented as given in Fig.2

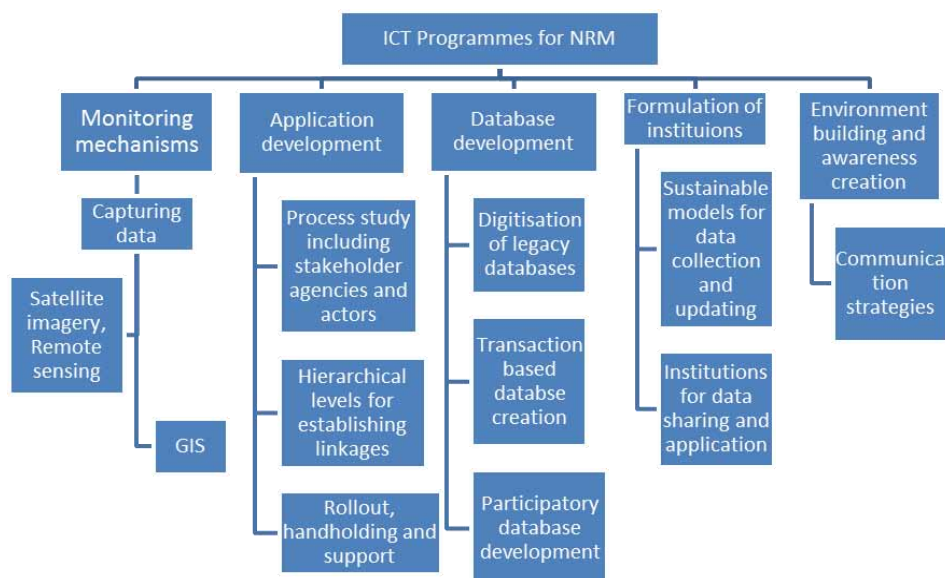


Figure 2 : Key components of a comprehensive ICT programmes

Based on the components identified, we shall now attempt to list and describe plausible actions required for effective ICT interventions for sustainable NRM.

ICT enabled NRM: Action points for effective intervention

Drawing from the cases above and as understood from the discussion on the dimensions of sustainable NRM, the key action points of a comprehensive ICT programme to practice and promote sustainable NRM shall be conceived as given below.

1. Enhancing access to information: Mechanisms for easy access to useful information for sustainable growth are limited. In fact, latest information on resources, technology, climate, markets, prices and trends are required by rural communities for scheduling their operations and deciding upon production and marketing strategies. Customised information systems that provide such information would safeguard the communities against the odds of exploitation and depletion of resources. Other than providing content, this implies establishment of community information kiosks on a large scale with consultative functions. An enhanced and multifunctional model of the Village Knowledge Centres established by MSSRF would be able to meet the requirements of rural communities for effective NRM.

2. Online and off line transfer of technology and e- learning: Among various ICTs, the Internet plays the most vital role in the process of technology dissemination. However, this mode of technology transfer is constrained by lack of infrastructure, relevant content in local language and the pedagogical limitation of virtual learning. These constraints should be overcome by devising illustrative multimedia demonstrations of NRM practices as much interactively as possible. Tools for self instruction should be made available at rural kiosks in order to enhance the adoption of sustainable technologies. Interactive multimedia

products based on resources, crops, cultural and conservation practices etc could be produced and deployed in large scales, with emphasis on local conditions and issues. Need less to speak, all these products could also be made available online in regional languages.

In addition, existing mechanisms such as call centres, video conferencing, consultation with research and training institutes etc shall be strengthened and scaled up with provisions to deal with specific issues to sustainability instead of conventional queries on package of practices.

Research institutions, voluntary organisation etc shall initiate exclusive courses on sustainable development through their e- learning and distance education centres. Courses on concepts of sustainability and farm level interventions to enhance sustainability can be developed and offered to the public.

3. Grassroots level resource maps and resource data bases: Apart from the huge information systems that are maintained by national organisations, dynamic information systems that can monitor resource utilisation at the grassroots level could be developed. This can be done only by developing comprehensive databases of natural resources on a land parcel basis, with the participation of the people. This is not impractical as several pilot programmes have been successful in making participatory resource databases using GIS tools. For example, resource mapping by the Kerala Sathra Sahithya Parishad and resource maps and other databases developed at Thanalur in Malappuram District by the Information Kerala Mission have been utilised by the concerned local self government institutions for grassroots level planning

4. Updating legacy databases: There are several data bases that are being traditionally used by development agencies. The basic registers of agriculture at the agricultural offices, building register at the local government institutions, cadastral maps, land registers, lists of beneficiaries, etc are all databases that could be put to effective use in planning for sustainable NRM. However, these invaluable data sources are incomplete and are not updated. The recently debated databank on wetlands and paddy fields in Kerala is a classic example of generating natural resource database from existing records for formulating policies and local interventions

Digitisation of legacy databases to make use of the geographic, demographic and socio economic and resource related features of an area effectively could be a major ICT programme for sustainable use of resources. However, as seen from the review of ICT programmes on agriculture, no programme has been found to attempt this humungous task, which is also a pre requisite for robust and reliable planning process at the grassroots level.

5. e- governance for better coordination of development agencies: Better co-ordination among development agencies would result in responsive intervention, which is an important pre requisite for sustainable development. The archaic systems of service delivery of traditional development departments which are also lethargic tend to be

counterproductive, in many cases. This would also lead to decision making process without any relevant inputs from related domains. This can be overcome only by comprehensive e-governance applications that could render co ordination and integration among various development departments effective. It is widely reported that e- governance applications that ensure integration among departments are fewer in number (Keniston and Kumar 2008). This is of great relevance in agriculture as well as NRM as development in this sector requires dynamic integration among various departments and service providers for the farmers to fully benefit from their interventions.

6. Information systems: Information on sustainable NRM practices, optimisation of inputs, development and use of eco friendly technologies, sources of sustainable technologies, training resources etc can be made available to grassroots level organisations and development departments for wider adoption of sustainable alternatives.

7. Decision support systems: Local governments at various levels and development agencies can avail decision support systems developed exclusively for using common property resources and drawing up local level plans. This would require integration of various rural databases and development related information. Tools for impact assessment and estimation of eco system services, resource optimisation etc can be employed for grassroots level planning. Access to information on natural resources and dynamic data on climate, land use etc from authorised agencies shall also be integrated with these systems. Decision support systems with a view to facilitate local level planning have not been attempted so far, on an impressive scale.

8. Devising ICT enabled participatory tools: Instead of centralised mechanism for resource appraisal as done in the case of soil survey, effective ICT enabled participatory tools can be developed and employed to collect data on local level needs and resources. For instance, Akshaya kiosks in villages can be tremendously instrumental in preparing ward level resource maps, problem matrices, databases, local information systems etc that can be further used in development planning. Problems reported by farmers shall also be consolidated and reported to concerned agencies or institutions through this mechanism.

Repositories of local traditional knowledge on crops, cultural practices, adaptation techniques, traditional tools and farming equipments etc shall also be developed locally with facilities to access the information systematically and functionally.

9. Organising local groups and ICT enabled capability building: Since participation of stakeholders is the most important pre requisite for wider adoption of sustainable NRM practices, local resource groups of farmers and entrepreneurs have to be organised to facilitate adoption of sustainable practices. Existing farmer collectives shall also be trained on the concepts and issues of sustainability with local relevance. These groups can be imparted ICT enabled training to understand the issues better and to function as animators and change agents for supporting the community to find out sustainable alternate solutions.

As far as research in the field of ICT applications for sustainable natural resource management is concerned, the main research demand would include:

Conclusion

Information support to sustainable NRM is becoming increasingly important consequent to the sweeping transformational changes in the developing economies. Though it is a daunting task, no effort can be spared to pursue it. Considering the global as well as local concerns on sustainable growth, robust mechanisms to devise and implement alternatives to input intensive development should be put in place without any further delay. At the same time, feasibility and profitability of such alternate options also should be seriously considered as the less endowed rural communities the world over are striving to make an existence in the face of rampant globalisation. Any ICT programme with a focus on sustainability should address these two seemingly contradictory concerns. A robust ICT programme therefore should improve the knowledge and wisdom of communities to manage their natural resources scientifically with an eye for a very distant future. It should also facilitate the mundane institutions for resource management that would evolve out of necessity and conviction. Having said this, development of infrastructure as well as relevant content to enhance accessibility deserves prime attention at this point. It should also be accompanied by better co ordination and integration among the change agencies and development departments for sharing information and developing new content. Discrete and solitary efforts in this regard have to be integrated with common objectives and strategies. Capacity building for local governments, line departments, civil society organisations and rural communities also seems to be necessary to drive this objective. Interaction between policy makers and other stakeholders needs to have a new sense of purpose and commitment to bring about innovations in this domain.

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ICTs in Information Management and Networking- New Tools and Trends

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It is an unequivocal proposition that, Indian Agriculture has now entered a post-Green revolution stage. Demands for agricultural technology are changing and diversifying. The demands for Information are changing, from information on crop-technology and packages of practices in 1960s and 70s to the focus shifting to market prices in national and international markets and value-addition opportunities. The main objective of farmer's concern has shifted from high production to high returns, and hence issues like quality, timeliness and postharvest technology are gaining prominence in the farmers' queries. One of the areas where there is a consensus emerging, is that the existing extension system is unable to cope with the challenges facing the agricultural sector. At the same time extension is recognized as a key imperative in achieving the objectives of enhanced rural farm income. An average farmer in India is deprived of the information regarding latest farming technology and markets. This information is available in disconnected packets across the country. However, the people possessing the information have no cost effective means to reach the rural masses. The farmers too do not have an easy and affordable access to this information. Farmers in developing countries get much of that know-how from family, friends and input dealers. Public and private extensions are additional sources of information for farmers.

We know that the 'Information' is crucial in agricultural production, in addition to land and capital. Faster transmission of improved farm technologies can revolutionize agriculture. Matching the speed of technology transfer with that of farmer's acceptance can bring prosperity among farm families.

Let's look into the essence of what ICT is. Information and Communications Technology (ICT) is the hardware and software that enables data to be digitally processed, stored and communicated. ICT can be used to access, process, manage and present

information; model and control events; construct new understanding; and communicate with others. ICT, an interdisciplinary domain, focuses on providing learners with the tools to transform their learning and to enrich their learning environment. The knowledge, skills and behaviours identified for this domain enable students to:

- develop new thinking and learning skills that produce creative and innovative insights
- develop more productive ways of working and solving problems individually and collaboratively
- create information products that demonstrate their understanding of concepts, issues, relationships and processes
- express themselves in contemporary and socially relevant ways
- communicate locally and globally to solve problems and to share knowledge
- Understand the implications of the use of ICT and their social and ethical responsibilities as users of ICT.

Learning in this domain enables learners to focus on the task to be accomplished rather than on the technology they are using to do the work. Through the selection and application of appropriate equipment, techniques and procedures, they process data and information skillfully to create information products in forms that are meaningful for themselves and their audience. These products effectively demonstrate their knowledge and understanding of the concepts, issues, relationships and processes that are the subject of the task.(www.introduction to information and communication Technology.com)

In the present context, ICTs or Information and Communication Technologies are emerging as an important tool for the development of societies and are the driving forces in economies world-wide. These new technologies are no longer confined to assist high-end research and development, but have made significant improvements in the life-styles and the efficiency-levels in all sectors of economy. New businesses like "Business Process Outsourcing (BPOs)", Banking and Insurance, the entertainment industry and other industries and organizations, are all taking maximum advantage of the ICT revolution

The Agriculture sector is gearing itself to make optimal use of the new information and communication technologies. At the Government of India Level, a number of important initiatives have been taken to provide IT Hardware and connectivity to all organizations involved in Agricultural education, research, development and dissemination. Simultaneously, agricultural content development initiatives have been taken by Ministry of Agriculture, in collaboration with National Informatics Centre (NIC), to provide marketing information of various agricultural commodities to the farming community. Another content-creation and aggregation initiative is being supported by Indian Council of Agricultural Research (ICAR), under its World Bank aided project - National Agricultural Innovations Project (NAIP), where in leading ICT institutions like IIT Kanpur, IIT Mumbai, IITKM, Kozhikode, NAARM, Hyderabad and International Crops Research Institute for Semi-Arid Tropics (ICRISAT) have been roped in to guide National Agricultural Research

System to design, develop and implement Knowledge Management Systems (KMS) in Agriculture. ICTs are thus emerging as very important tools for Agricultural Extension.

Changing Agricultural Scenario and Information Needs

It is a truth that so far, we are adopting traditional systems such as pamphlets, posters, radios, and television to disseminate agricultural information to the farmers. In this system, there is a time gap in transferring the information to the farmers. It is important that accurate information reaches the farmers at the right time. The rapid growth of Information Technology and Communications Systems has changed the scenario entirely. Now linking two computers from anywhere in the world is an easy task. The emergence of an internet and E-mail system has changed the inter-relations of personal contact. Various ICT projects have been initiated by the Government, NGOs and private companies. The result has been linking of villages with wired network in many parts of the country.

Practically, Agricultural extension played a very vital role in achieving the targets of green revolution. The post green revolution scenario is witnessing emergence of new paradigms like sustainable agriculture, agri-business & contract farming. The advances in Information Communication Technology (ICT) are poised to compliment extension efforts for transfer of technology. Farmers have specific information needs. The main focus of ICT in agriculture is meeting the farmers' needs for information. The following are some vital needs of farmers that seem to be imperative for the growth and development of agriculture.

- **Market information:** Market information including price updates of agricultural commodities of surrounding districts on a daily basis. For farmers, the price updates of markets outside their villages have a higher priority so that they can compare the prices and choose to sell at the appropriate place.
- **Information on latest techniques and technologies:** Continuous advancement in technology brings up gradation to agricultural machinery and techniques too. Up to date information regarding latest technologies in agriculture and animal husbandry is of immense importance for growth.
- **Information about rural development programs and subsidies:** Provision of detailed information on Government initiatives for rural development for those the programs are addressed. The areas that suffer from droughts, floods or other natural disasters frequently receive grants and subsidies from the Government. Information related to these programs is particularly important to small and marginal farmers.
- **Weather forecasting:** Updated information on weather such as temperature, humidity, forecasts on rains.
- **Latest (best) packages of practices:** Information on "best practices" of cultivation is important need of the farmers. Information regarding drought resistant varieties of certain crops can be important for farmers to withstand longstanding droughts in some areas.
- **Post-harvest technology:** Education on post-harvest technology and storage is as vital as pre-harvest. Farmers are getting aware of the value addition of food processing.

- General agricultural news 4: General news and information related to various agricultural events in villages and districts.
- Information on insurance/claim processing: Detailed information on crop insurance schemes, the type of damage covered and compensation offered premiums to be paid, etc.
- Input prices and availability: Information relating to the availability of agricultural inputs like seeds, fertilizers, manures, etc. and prices.
- Early warning and management of diseases and pests: In the areas of continuous droughts, pests and diseases do not generally pose a major threat. However, in other areas this information is useful. Also, early warning in case of some crops like sugarcane is important.
- Soil testing and soil sampling information: Information related to testing of quality or nature of soil is very important for farmers as the soil directly relates to productivity of crops. If this information is easily available to the farmers, it prepares farmers to get the best produce given the resources.

They need locally relevant information for better farming. Farmers' operations have numerous characteristics: different soil types, crops, weather, pest complexes and marketing arrangements etc. Relevant information on these aspects will help the farmers to achieve the maximum profits. The extent and rate of change now occurring in the development of ICTs have opened the way for significant change in crop production management, agricultural decision-making and information dissemination.

The farmers depend on extension personnel to get the proper advice to cultivate the crop. The information needed may relate to different schemes, crops, technologies, seeds, fertilizers, pesticides, availability of fertilizers, seedlings, biopesticides, soil fertility, pest and disease diagnosis and many more. Agricultural marketing information is essential for farmers to increase their profits. Information such as price details of seeds, fertilizers, pesticides and availability of these products in the market enables the farmer to take decision in choosing right seed, fertilizer and pesticide required for the better farming. Vital information, that flows from the agricultural policy maker's desk, such as fixation of procurement price, procurement targets and policy relating to exports helps to farmers to get maximum profits.

Similarly, weather forecasting is one of the important requirements of farming and it helps the farmers to take the right decision at the right time. The research is advancing rapidly with the advent of high performance computing and communications systems to predict weather forecasting. There are a few key areas for action by the systems (both in public and private domain), to enable enhanced income for farmers and the rural community. These are:

- Reform in food laws
- Improving cropping practices and efficiency
- Improving infrastructure

- Creation of a common Indian market by removing barriers in movement of agriculture produce.

One of the areas where there is a consensus emerging, is that the existing extension system is unable to cope with the challenges facing the agricultural sector. At the same time extension is recognized as a key imperative in achieving the objectives of enhanced rural farm income. An average farmer in India is deprived of the information regarding latest farming technology and markets. This information is available in disconnected packets across the country. But the people possessing the information have no cost effective means to reach the rural masses. The farmers too do not have an easy and affordable access to this information. Farmers in developing countries get much of that know-how from family, friends and input dealers. Public and private extension services are additional sources of information for farmers. Information is crucial in agricultural production, in addition to land and capital. Faster transmission of improved farm technologies can revolutionise agriculture. There are several pockets of excellence in both knowledge and practices, and ICT offers the promise of overcoming this. More investment in ICT applications for agriculture development in India is the need of the hour, not only to redress the growing imbalance in information, but also to reduce property, increase participation, improve governance, manage natural resources and improve opportunities for women. These information needs cannot be addressed by one department or Agricultural scientists alone. There has to be an on-line network of multi-stakeholders in the Agriculture-value-chain to address farmers' current and emerging information needs. There are many other information needs of the farmers. ICT enabled systems are more suitable to address the information needs of the clientele groups.

Traditional Information Access Mechanism

We are aware that the traditional information access mechanism of farmers was mostly influenced by the respective state government/agriculture University' information delivery mechanisms. In early fifties, the Gramsevak/VLW's served as a key-man in Community Development Programme. In early fifties, the Gramsevak/VLW's served as a key-man in Community Development Programme. The National Extension Scheme launched in 1953, was the first scheme to have specific focus on Agricultural extension. In early sixties and seventies the department of Agriculture at district level was the sole information provider on the crop varieties, package of practices and also on pest an, disease control measures to be taken. Their efforts were complemented by the farmers and Agriculture input dealers, by the farmers and Agriculture input dealers, by canvassing these messages to the fellow farmers. The launching of Training and Visit system (T&V), under National Agricultural Extension Projects I, II and III, during 1970s and B0 gave a great fillip to information delivery mechanism of State Agriculture departments, as it introduced a system of regular and crop/ season specific interaction among Agricultural research scientists, State Agriculture departments and farmers. The fortnightly workshops were a novel concept to have a regular interaction among the scientists and the extension functionaries. The establishment of KVKs (in almost all rural districts, and support of mass-media particularly the All India Radio and Doordarshan have played a very important role in the diffusion of new Agricultural technologies. The print media, the vernacular press also

supplemented the extension efforts at local levels. The private T.V. channels are a new entry, and have got tremendous positive feedback from farmers. The other traditional extension mechanisms included demonstrations, farmers meetings and krishi-melas at district, state and national level.

Looking into the traditional roles of agricultural extension since its formation and discovery, it shows that single commodity focused extension, top-down approach, farmers as passive learners, extension agent doing it alone, technology transfer of inputs, training farmers and prescriptive form of extension are the traditional roles of Extension with responses above 70%. Other roles are improving farm productivity only, provision of market information, and fixed/uniform approaches to extension delivery. Looking at these roles, one could find out that they no longer fit into our changing technological and fast moving era. According to Anadajayasekaram *et al.*, (2008), extension services were traditionally assumed to be the conducts for transferring technologies developed by the research system to the farmers. The system however, has been under severe attack for not being able to contribute to desire developmental impacted in developing countries. With changing circumstances of agriculture and increasing trends of globalizing, commercialization and drive towards sustainability, extension is being looked upon to play an expanded role with a diverse set of objectives to actually impact on people lives. Over the past two decades, the agricultural research and development system has undergone drastic transformation and societies have moved towards an accelerated agricultural modernization and macro-economic reduction of public services. This is due to the entrants of numerous extension service producers and the changing nature of time. At present agricultural extension is undergoing critical and objective reform. These findings are in line with Anadajayasekaram *et al.*, (2008), that the policy and institutional context in which agricultural research and innovation occurs has changed dramatically. Rapid changes continue to take place in the structure and authority of governments the global economy, the structure of the farming sector and in the global and local food industries and retract business. The institutional landscape is also changing dramatically. The civil society, farmers' organization and NGOs are increasingly playing an important role in agricultural research and development. The cross cultural linkages between agriculture and other sectors (such as water, health, energy and education) are becoming very important. (<http://www.sciencepub.net/researcher>)

Information and Communication Technologies (ICTs) in simple terms

ICT or Information and Communications Technology in simple terms, can be defined as the basket of technologies, which assist or support in storage, processing of data/ information, or in dissemination/ communication of data/ information, or both. ICT thus includes technologies such as desktop and laptop computers, software, peripherals and connection to the Internet that are intended to fulfill information processing and communication functions, According to Wikipedia (2008), the term ICT is the broader term of Information Technology (IT), to explicitly include the field of electronic communication, in addition to IT. The term IT is defined as "the study design, development, implementation, support or management of computer based information systems, particularly software

applications and computer hardware.' IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information, securely.

Farmers who have better access to ICT have better lives because of the following:

- Access to price information – farmers will be informed of the accurate current prices and the demands of the products. Hence, they will be able to competitively negotiate in the agricultural economy and their incomes will be improved.
- Access to agriculture information – according to the review of global and national agricultural information systems done by IICD with support from DFID in 2003, there is a need for coordination and streamlining of existing agriculture information sources, both internationally and within the developing countries. The information provided is usually too scientific that farmers cannot comprehend. Therefore, it is vital that the local information to be relayed to the farmers must be simplified.
- Access to national and international markets – Increasing the level of access of farmers is very vital in order to simplify contact between the sellers and the buyers, to publicize agricultural exports, facilitate online trading, and increase the awareness of producers on potential market opportunities including consumer and price trends.
- Increasing production efficiency – due to several environmental threats such as climate change, drought, poor soil, erosion and pests, the livelihood of farmers are unstable. Thus, the flow of information regarding new techniques in production would open up new opportunities to farmers by documenting and sharing their experiences.
- Creating a conducive policy environment – through the flow of information from the farmers to policy makers, a favorable policy on development and sustainable growth of the agricultural sector will be achieved.

(Source:http://en.wikipedia.org/wiki/information_and_communication_technology).

ICT is thus used as an umbrella term that includes any communication device or application, encompassing radio, television, cellular phones, computer and network hardware and software, satellite systems various and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. The importance of ICT lies less in the technology itself, than in its ability to create greater access to information and communication among the hitherto un-reached geographies and populations. Appropriate ICT interventions are yielding positive results in developing and underdeveloped economies. The "Grameen Phone" initiative in Bangladesh, Kothamale Radio project in Sri Lanka, and ITC's e-Chaupals in India, are examples of such innovations. Many countries around the world have established organizations for the promotion of ICTs, because it is feared that unless less technologically advanced areas have a chance to catch up, the increasing technological advances in developed nations will only serve to aggravate the already existing economic gap between technological "have" and "have not" areas.

The relevance of ICTs for Agricultural Development in general and for Agricultural Extension in particular is extremely high for a country like India. ICTs are most natural allies to facilitate the outreach of Agricultural extension system in the country. Despite a large, well-educated, well-trained and well organized Agricultural extension manpower, around 60% of farmers in the country still remain un-reached (NSSO, 2005), not served by any extension agency or functionary. Of the 40%, who has some access to Agricultural Information, the major sources of this information are Radio and Television. The telephone has just started to make its presence felt on this scenario. During last four years of its operations, the Kisan Call Centres (KCC) helpline 1551, has registered over 2.4 million (24 Lakh) calls. Internet supporting Information-Kiosks are also serving the farming community, in many parts of the country. Hence ICTs are highly relevant for Agricultural Extension scientists, researchers, functionaries and organizations.

Cyber Extension: Use of ICTs in Agricultural Extension

In reality, the 'Agricultural Extension Services' is the backbone of the Agricultural Development of a country. Earlier, Krushikarma Viyapathy Sevaka Niladari (KVSN: Agriculture Extension Service Officer) were the grass root level extension officers providing face to face extension services, which facilitated the smooth transfer of technologies and information to the community. The ICT initiative; 'Cyber Extension' mechanism has been implemented in Sri Lanka in the year 2004 as an appropriate information exchange mechanism affordable to rural farmers to satisfy their information needs. The project established 51 Cyber Extension Units (CEU) at Agriculture Instructors offices, Govijana Kendra (Agrarian Services Centres) and district Agriculture Training Centres (DACTs) during the period of 2004-2007. Each Cyber units equipped with a technically high end multimedia computer, scanner, laser printer, digital camera, uninterruptible power supply unit (UPS) and required furniture.

Information and Communication Technologies (ICTs) have opened a whole new set of options for the Agricultural Extension scientists, Extension officers in the research and extension system to improve the speed, accuracy of the communications at relatively lower costs. ICT tools like Internet, e-mail, on- line Expert Systems, Call Centres and information portals on Agricultural marketing information, packages of practices and subject specific discussion groups on Internet have enhanced access of Extension personnel to the latest information within and outside the country. Communication is the Central mechanism of Extension process. ICTs provide new dimensions to Communication as a process. These include:

- Global access to Information resources, beyond state and national boundaries (improved reach).
- Most of the time access is free (less cost).
- Instant access to important resources -people and literature. Extension
- Journals, newsletters (less time).
- Facilitates two-way communication -e-mails, chat Groups, discussion forums

- Information is available any time. Little or virtually no chance for Information-distortion, as the communication is between the user and communicator directly
- Easy documentation as all the communication is in digital form, including e-mails, audio and video exchange.

All the above dimensions of proper use of ICTs have generated a lot of interest among the Agricultural Extension scientists and extension functionaries. This whole new field of interest and application- "Use of ICTs in Agricultural Extension" is emerging as a body of knowledge, popularly known as "Cyber Extension".

Defining Cyber Extension.

Actually, cyber extension is an agricultural information exchange mechanism over cyber space, the imaginary space behind the interconnected computer networks through telecommunication means. It utilizes the power of networks, computer communications and interactive multimedia to facilitate information sharing mechanism (Wijekoon, 2003). It includes effective use of ICT, national & International Information Networks, internet, expert systems, multi-media learning systems & computer based training systems to improve information access to the farmers, extension workers, research scientists & extension managers. (<http://en.wikipedia.org/wiki/cyberextension>). Cyber - According to Oxford Dictionary the word Cyber means, "relating to Information Technology, the Internet, and virtual reality, the *"Cyber Space"*. 'Cyber Space' is the imaginary or virtual space of computers connected with each other on networks, across the globe. These computers can access information in the form of text, graphic, audio, video and animation files. Software tools on networks provide facilities to interactively access the information from connected servers. The cyber space thus, can be defined as the imaginary space behind the interconnected telecommunications and computer networks, and the virtual world. Extension stands for "the action or process of enlarging or extending something". It could be extension of area, time or space. Cyber Extension can be defined as the "Extension over cyber space". As the word extension is subject-neutral, so is cyber extension' But in the applied context of agriculture, cyber extension means *"Using the power of online computer networks with the help of communication channels to deliver the content in the form of text, graphics, audio and video either passively or interactively to facilitate dissemination agricultural of technology"*. Cyber Extension includes effective use of Information and Communication Technology, national and international information networks, internet, expert systems, multimedia learning systems and computer based training systems to improve information access to the farmers, extension workers, research scientists and extension managers. The same concept is being promoted under the titles like e-Extension, tele-Extension, and e-Agriculture by various national and international organizations/universities.

Cyber Extension Tools

As Cyber Extension is *"Extension over Cyber Space"* all the tools of Internet Used for browsing Agricultural Information from the basket of Cyber Extension tools. The major Cyber Extension tools are:

- E-Mail
- Interactive Expert Systems on Crop Pests and Diseases.

- INTERNET browsing for Extension Information.
- Video Conferencing.
- Call Centers; SATCOM Networks.
- Discussion Groups and News Groups

E-Mail

Let's now see the most conspicuous mailing system i.e. the Electronic Mail, most commonly referred to as email or e-mail since 1993, is a method of exchanging digital messages from an author to one or more recipients. Modern email operates across the Internet or other computer networks. Some early email systems required that the author and the recipient both be online at the same time, in common with instant messaging. Today's email systems are based on a store-and-forward model. Email servers accept, forward, deliver, and store messages. Neither the users nor their computers are required to be online simultaneously; they need connect only briefly, typically to an email server, for as long as it takes to send or receive messages. (<http://en.wikipedia.org/wiki/email>). E-mail is the most often used communication tools in the new age. In all sectors- education, business, services, e-mail has replaced letters, faxes and even telephone calls in the new generation working culture. In Agriculture sector the use of e-mail is limited by the non-availability of connectivity to the cutting-edge functionaries in the State Departments of Agriculture. This limitation is being overcome very fast and most of the state governments have initiated projects to connect all their departments, and also field level offices to provide on-line connectivity to the officers and staff. The mission mode projects under Government of India's National e-Governance plan also all the central government offices working under the Ministry of Agriculture are being given high bandwidth connectivity. Once all this system is in place (which is likely to be within the 11th Five Year Plan itself), e-mail should become the most powerful extension communication mechanism among the Agricultural scientists, extension functionaries, agricultural processing and supply-chain companies and the farmers. Even now some KVKs like KVK Babaleswar in Ahmednagar and Baramati in Pune (Maharashtra) are using email mechanism highly effectively to send extension messages to innovative farmers.

Interactive Expert Systems on Crop Pests and Diseases

In Agriculture, applications of expert system are mainly found in the area of disease diagnosis and pest controls. Many domain specific expert systems are being used at different levels. This system is developed for the purpose of identifying diseases and pests with control measures, fertilizer recommendation system, water management system, and identification of farm implements for leading crops. The expert system was developed with rule-based expert system, using ESTA (Expert System for Text Animation). This designed system is intended for the diagnosis of common diseases occurring in the rice plant. The ESTA programming is based on logic programming approach. It contains knowledge about symptoms and remedies of diseases in the rice plant appearing during their life span.

In the Interactive Expert module, domain specific expertise is acquired from human experts. The acquired knowledge is analyzed and then processed to obtain the best conclusion for the problem. The knowledge is then transferred to the IS experts to verify for converting into expert system program. Once the knowledge acquired from domain experts or domain resources is verified by the IS experts, it is transferred from the Interactive Expert module to the expert system program module for converting into expert system program. For ESTA system, expert knowledge has been acquired from standard literature related to the rice plants. "Illustrated guide to integrated pest management in rice in tropical Asia." (Source:

<http://www.cscjournals.org/csc/manuscript/Journals/IJAE/volume1/Issue1/IJAE>).

It can be stated that expert systems are the programmes written to solve problems or give advice in specific subjects. In the Agricultural context the subject specific knowledge of a particular expert or a number of experts on crop-pest or disease is organized in a computer program in such a way that a user (farmer or extension worker) can indicate the symptoms in text form, data form or digital image (with color), the computer assists the user to diagnose the problem- the pest or disease and then depending on its extent and stage of problem suggests preventive as well as curative measures for the same. The additional information on pest life-cycle favourable conditions for their growth may also be indicated. Expert systems can be used both in on-line and offline mode. In on-line mode, the users can interact with the research organizations expert systems to diagnose the field problems and can offer advice to farmers and fisherman. A number of ICAR institutions are working on development of crop-specific Expert systems to assist the field functionaries. The expert-systems are thus very important tools for Cyber Extension.

INTERNET Browsing for Extension Information

Simply browsing the World Wide Web for the required information is the most often used "Information Access" method on the Internet. The agricultural scientists, students, extension functionaries, traders and farmers, all can access required information in a very short time, if the same is available on the Internet. The information on crop-science and package of practices being hosted and up-loaded by ICAR institutes and State Agriculture Universities (SAUs), and the information on Government programmes projects, schemes are being hosted by concerned state government or central government departments/agencies. For example all the relevant information on Government of India centrally sponsored schemes on 'support to the State Extension Programmes for Extension Reforms', "Mass Media Support to Agriculture Extension" and "Agri clinics and Agribusiness Centres" are available on MANAGE (National Institute of Agricultural Extension Management) web-site-www.manage.gov.in. The mega-portal of "dacnet.nic.in" provides information all divisions, schemes, of the Ministry of Agriculture, government of India. Similarly information on major state government supported projects is available on their web-sites. This information is extremely helpful for the farmers, extension functionaries and the agricultural scientists and students. The demand for information on price of agricultural produce has been growing, as more and farmers are asking for the prices of their produce in near-by markets. A number of web-sites are providing the Agricultural produce prices on on-line basis. The important websites giving the Agricultural market price information are: www.agmarknet.nic.in, www.agriwatch.com, market.ap.nic.in, emandi.mla.iitk.ac.in etc.

Web-browsing for finding the required information is growing at rural information kiosks as well. In remote villages of Pondicherry, MSSRF has reported that number of farmers visit the Village Information Kiosks to find see and read the Newspapers on-line.

Similarly, the 'fish watch' web portal of the Central Marine Fisheries Research Institute (CMFRI) is another example. CMFRI has been conducting fishery survey along the Indian coast and estimating marine fish landings and effort expended. Gear wise, species wise, quarter wise fish landing data from the year 1962 for each maritime state of the country are being populated periodically at the Data Centre of CMFRI. This unique collation of first hand data based on the FAO approved sampling design has been the backbone of many a scientific endeavor carried out by avid fish researchers across the country and other parts of the globe. Having blazed an illustrious trail for more than six decades, CMFRI has initiated a new system of field information dispensation on a near real time basis. As the first phase of this effort, the raised landing figures and the landing centre price range of important resources of six major fishing harbours of the country are being published here. The landing figures (in kg) indicate the quantity of selected resources which were brought to the respective harbours during a 24 hours period starting from 12:00 noon of the first calendar day to 12:00 noon of the subsequent day. These figures are updated at 1600 Hrs every working day on as and where available base.

Video Conferencing

Now let's see the video conferencing method. Videoconferencing is the conduct of a videoconference (also known as a video conference or videoteleconference) by a set of telecommunication technologies which allow two or more locations to communicate by simultaneous two-way video and audio transmissions. It has also been called 'visual collaboration' and is a type of groupware. Videoconferencing differs from videophone calls in that it's designed to serve a conference or multiple locations rather than individuals.^[1] It is an intermediate form of videotelephony, first deployed commercially in the United States by AT&T Corporation during the early 1970s as part of their development of Picture phone technology. With the introduction of relatively low cost, high capacity broadband telecommunication services in the late 1990s, coupled with powerful computing processors and video compression techniques, videoconferencing has made significant inroads in business, education, medicine and media. Like all long distance communications technologies (such as phone and Internet), by reducing the need to travel to bring people together the technology also contributes to reductions in carbon emissions, thereby helping to reduce global warming. (Source: <http://en.wikipedia.org/wiki/Videoconferencing>).

Video conferencing (VC) is remote meeting between two or more individual present at geographically dispersed locations. National Informatics Centre (NIC), in India has established Video Conferencing studios at 490 places in the country (as on 15 September 2007, source: www.vidcon.nic.in). These studios provide state-of-the-art 2-way video-conferencing facility among 2-4 sites at one point of time. As 15 State Agricultural

Universities including-Assam Agricultural University, Jorhat (Assam), Anand Agricultural University , Anand (Gujarat), Acharya N.G. Ranga Agricultural University, Hyderabad (Andhra Pradesh), University of Agricultural Science, Dharwad (Karnataka), Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra), CCS Haryana Agricultural University, Hissar (Haryana), Punjab Agricultural University, Ludhiana (Punjab), Maharana Pratap Agricultural University, Udaipur (Rajasthan), Sher-Ke-Kashmir, University of Agriculture Science and Technology, Jammu (J & K), G.B.Pant University of Agriculture Science and Technology, Pantnagar (Uttarakhand), Rajender Agriculture University, Samastipur (Bihar), Birsa Agriculture University, Ranchi (Jharkhand), West Bengal Agricultural University, Kalyani (West Bengal), Allahabad Agricultural Institute, Naini (Uttar Pradesh), CS Azad University for Agriculture Science and Technology, Kanpur (Uttar Pradesh), along with a number of State Level Agricultural Extension and Management Training Institutions (SAMETIs) of Himachal Pradesh, Orissa, Maharashtra, Andhra Pradesh, Jharkhand and Bihar are having video conferencing facilities, this infrastructure provides a huge opportunity for two-way interaction among the scientists, extension workers and farming community of the concerned states. This facility is being extensively used for interaction among resource persons and training. Participant in training programmes being conducted at SAMETIs. Still there is a lot of untapped potential, the video conferencing offers to the farming community. At the village kiosks level, the VC facility is being used very effectively by Tamilnadu University of Veterinary and Animal Sciences (TANUVAS), to interact with the farmers at village information kiosks having two-way VC facility in the Madurai district of Tamilnadu.

Call Centres and SATCOM Networks

Call Centres play an inevitable role in ICT ventures. A call centre is a centralized office used for the purpose of receiving or transmitting a large volume of requests by telephone. An inbound call centre is operated by a company to administer incoming product support or information inquiries from consumers. A call centre is operated through an extensive open workspace for call centre agents, with work stations that include a computer for each agent, a telephone set/headset connected to a telecom switch, and one or more supervisor stations. It can be independently operated or networked with additional centres, often linked to a corporate computer network, including mainframes, microcomputers and LANs. Increasingly, the voice and data pathways into the centre are linked through a set of new technologies called computer telephony integration (CTI). Call centre technology is subject to improvements and innovations. Some of these technologies include speech recognition software to allow computers to handle first level of customer support, text mining and natural language processing to allow better customer handling, agent training by automatic mining of best practices from past interactions, support automation and many other technologies to improve agent productivity and customer satisfaction. Automatic lead selection or lead steering is also intended to improve efficiencies, both for inbound and outbound campaigns, whereby inbound calls are intended to quickly land with the appropriate agent to handle the task, whilst minimizing wait times and long lists of irrelevant options for people calling in, as well as for outbound calls, where lead selection allows management to designate what type of leads go to which

agent based on factors including skill, socioeconomic factors and past performance and percentage likelihood of closing a sale per lead. (<http://en.wikipedia.org/wiki/callcentre>).

So far, the call centres have proved to be an extremely effective mechanism for customer service support in a number of services and industries. Almost all Banks, Consumer Appliances Manufacturing Companies, Automobiles and Railways, etc, have made use of call centers to provide online, 24X7 (round the clock on all seven days) information services to their customers. In India the Kisan Call Centres (KCC) were established on January 21, 2004, Providing online agriculture advice and information to the farmers, across the whole country, using a toll free telephone number 1551. The farmers can make a call from anywhere in the state, the call lands at the concerned state call centre and the farmer gets the response in his/her own language from the agriculture graduates at the call centre or the experts at identified agriculture university or research centre in the state. Over 20 lakh calls were answered within first three years of KCC. Thus Kisan Call Centres are an important cyber extension tools to provide two-way communication mechanism between the agricultural scientist and the farmers. Some of the states (e.g. Andhra Pradesh) and a few State Agricultural Universities (e.g. CCSHAU, Hissar) are running their own call centres in addition to Kisan Call Centre.

SATCOM Networks

SATCOM (which stands for "satellite communication") is an artificial satellite that is used to help telecommunication by reflecting or relaying signals into space and back down to earth. It is the most powerful form of radio and can cover far more distance and wider areas than other radios. It can also communicate with words, pictures and other forms of information. The Satcom system passed to General Electric with its purchase of RCA in 1986. RCA Americom became GE American Communications (GE Americom) and the satellite construction division became GE Astro Space. GE Astro Space was sold to Martin Marietta (now Lockheed Martin Space Systems) in 1993. In 2001 GE sold GE Americom to SES Global, creating SES Americom. (<http://en.wikipedia.org/wiki/satcomnetworks>). Satellite Communications (SATCOM) provide another option for one-way or two-way communication on audio as well as video. Development Education and Communication Unit (DECU) of Indian Space Research Organisation (ISRO) has established a number of communication studios to provide one-way video and two-way audio facilities to support development communication. These SATCOM studios offer excellent services to agricultural scientists to communicate with farming community on video. One-way video and two-way audio sets are highly economic (within a price range Rs.50, 000/- to Rs.60, 000/-) and have been set up at more than 3000 locations in the country, under various projects. This infrastructure is being used optimally some of the agricultural universities, The Anand Agricultural University (AAU), Gujarat, runs a programme called Gujarat Satellite Krishi Gosthee (GAUSAT-KRU), providing one-way video and two-way audio Communication among the scientists of AAU and the farmers of the state. The scientists of AAU, come to the SATCOM studio of Gujarat at Gandhinagar, and the farmers interact with them from the sardar smriti Kendras (SSKs) having SATCOM facilities at various districts.

The SATCOM is thus one of the important tools of Cyber Extension to facilitate two-way interaction among the stakeholders.

Success Stories of Cyber Extension

Success Case studies in Cyber Extension do have a pivotal role. There are several Cyber Extension initiatives in place in India, each addressing a part of the needs. The role of extension machinery should therefore be to harness each of them so that the complete package is available to the target-population. The expectation is that Cyber extension will facilitate the country to bridge the divide between expertise and the recipients. Several organizations/ agencies have tried various models fueled by this promise and now time may be appropriate to sit and analyze, in order to see what is likely to work better for farmers in rural areas.

The broad classification of ICT initiatives, currently in place include:

- Central Government initiatives to provide connectivity to Extension system - NATP-ITD component, ICAR- Extension component under NATP, NIC initiative in Kolhapur, Sangli Districts of Maharashtra (Warna wired Villages).
- State initiatives: Maharashtra Government initiative to promote Information kiosks, Kerala Government (Akshaya project) to connect all village panchayat etc.
- NGOs projects: Information Villages project in Pondicherry by MSSRF, Chennai
- Rural connectivity and allied services providers such as Drishtee, n-logue etc.
- Private and co-operative sector transaction related initiatives such as those of ITC, Mahindra, and EID parry, NDDB, etc.
- Pure information services providers such as Kisan, community India, Agriwatch, India agronet, etc.
- Multiple rural services, which include agriculture extension such as Warna, Gyandoot, Tarahaat etc.
- Knowledge networks and knowledge banks such as Honey Bee Network, Harit Gyan, and Indian Society of Agri-Business professionals etc.

In addition to these, there is another entity involved – entrepreneurs operating as partners in the form of kiosk owners, franchisees, in the districts and taluks. Most of the initiatives work with entrepreneurs as partners (at village level). These entrepreneurs are the final links in the chain. The sustainability of all these initiatives is critically linked to the sustainability of these entrepreneurs.

Success Stories

Akshaya project: E-krisi project of Kerala Government

An innovative project implemented in the State of Kerala named as ‘Akshaya’, aimed at bridging the digital divide, addresses the issues of ICT access, basic skill sets and availability of relevant content. Quality ICT dissemination and service delivery facilities (‘Akshaya Centres’) are set up within a maximum of 2 kilometers for any household and

networked leveraging entrepreneurship. Today, Akshaya is acting as an instrument in rural empowerment and economic development. The project is a catalyst in creating massive economic growth and creation of direct and indirect employment in the State by focusing on the various facets of e-learning, e-transaction, e-governance etc. Thus, the project is having a long-standing impact on the social, economic and political scenario of the State. The 'Akshaya' project, first started in the rural Malappuram district of Kerala, India, and is now spread over to seven more districts in the state was the- first district-wide e-literacy project in India and one of the largest known Internet Protocol (IP) based wireless networks in the world. In November 2002, the state government of Kerala put into place a project, piloted in Malappuram that aimed for one person in every family to be computer literate in Kerala, to be familiarized with the basic use of computer and empowered to access innumerable services that Information and Communication Technology offers. (Source:<http://www.akshaya.kerala.gov.in/index.php/platform-for-services/184>)

Malappuram is now known as India's First E-literate District. The mission continues to make Kerala the First E-literate state in India" In Malappuram district alone, Akshaya has conducted one of the world's largest computer literacy drives, claiming to reach over 6,00,000 households, representing more than 3.6 million people, in less than 6 months. The project has created a unique brand of state-funded computer access centers, and simultaneously led to a massive wireless infrastructure, providing a wide range of services and making way to many future opportunities. The project involves setting up around 5000 multi-purpose community technology centres called Akshaya e-kendras across Kerala. Run by private entrepreneurs, each e-Kendra set up within 2-3 kilo metres of every household, will cater to the requirements of around 1000-3000 families to make available the power of networking and connectivity to common man. Akshaya is a social and economic catalyst focusing on the various facets of e-learning, e-transaction, e governance, information and communication. The major objective of the "Akshaya project" is to make at least one person in each of over 6 million families in the state, e-literate and Delivery of public service and e - governance applications through e-kendras. The specific objectives include:

- To enhance the quality of available IT infrastructure in the state, and also by providing facilities for rural connectivity infrastructure.
- To accelerate the development of local content relevant to the population.
- To enable e-transaction and e-governance services through the centres.
- Generate over 50,000 employment opportunities in 3 years.
- To bridge the gap between the 'Information poor and the Information Rich'.
- Akshaya Centres to work as social and economic catalysts for the overall development of the society
- To empower individuals and communities through enhanced access Information, education and communication facilities.
- To integrate communities through creation of e-networks and development of the core sectors like Agriculture, Health, Education, Industry and Resources.

Access Points

The project has already connected 634 villages through e-centres in Malappuram District in the phase I. The second phase of the Akshaya Project was rolled out in seven districts such as Kasargod, Kannur, Kozhikode, Thrissur, Ernakulam, Pathanamthitta and Kollam in 2004, establishing 133 more e-centres. Further the state Government has decided to implement project in remaining six more districts namely Thiruvananthapuram, Alappuzha, Kottayam, Idukki, Palakkad and Wayanad. Thus Kerala will become the first Indian state to have a comprehensive e-Governance Project.

Key Services

Akshaya works on a 5+ 8+ 5 model towards achieving sustainability. The first five are core services that are offered by all the Akshaya Centres. Eight services are more related to industry and are offered by Selected Akshaya Centre's. There are also five ways to maintain good relation and to update with community. The core services include:

a) Training centre

A very important service, at Akshaya Centre is imparting programmes to citizens. All the courses are approved by the Government and a certification for merit will also be provided through an online certification mechanism. Some of the courses offered are the following- Basic Computer Literacy Package, e-vidya-MS office Package, Spoken English course programme, Arabic Typing Tutor, Multimedia Training Programmes, Hardware Assembling and Maintenance and Computer Courses/e-tuition for Students. All these courses have a common fee structure, and govt certification through an online package. The Govt is providing assistance to faculty training, course module development, continuous training support and certification.

b) Information Kiosk

Actually 'Akshaya' is envisaged as a one stop information centre. All kinds of information will be made available through the centres. Content has been already generated in five core areas including, Health, Agriculture, Career, Education and Laws and regulations. Govt also digitized all applications forms, govt schemes and delivered through Akshaya network. Encouragement for digitizing and updating locally relevant content is also given to Akshaya Centres.

c) E-Transaction centre

Extension of friend's services through Akshaya centres is implemented through this initiative. Presently KSEB and BSNL bills are collected through this package. Entrepreneurs can collect Rs.5 per bill customer for offering this service.

d) e-governance cell

Government already had taken decisions to convert Akshaya Centres as the last mile units for e-governance services to the public, which include, Public Grievances Redressal System, Decision Support systems, Online processing of applications, information dissemination services, digital extension of various campaign/awareness programmes, telemedicine, agriculture intervention etc. Many initiatives like e-parathi (District Collector's Public Grievance Redressal Mechanism, e-krishi, etc has been started).

e) Communication hub

Akshaya centres will also be developed as a Communication hub, which will have all ICT based communication facilities to the common man. In Malappuram all the Akshaya Centres are connected to wireless Internet which enable the centres for various connectivity based services. Intranet based services are also initiated through the network. This initiative is very important in Kerala as Kerala has lot of population living outside the country. The next category under Akshaya Business Development has identified eight services. These include-Digitization and Data Management, Hardware Sales and Maintenance, Financial kiosk, Travel and Tourism, Multimedia, Animation and Designing centre, IT enabled Vocational Training, Health Care and product Selling Division. In addition, the Akshaya project has identified 5 ways to maintain good relations with the community. These are important steps to keep community informed and interested in new developments. These are- 'shradha' - The Kids club, 'Mithra'- Club for the unemployed, 'Sakthi'- The women's club, 'Bhoomi', - The Farmers club and Friends of Akshaya.

Warana Wired Village project

A cluster of 70 villages in Maharashtra named as Warana Nagar, is an eye of the "Wired Villages" project. In 1960, a visionary shri Tahasaheb Kore propagated the idea of co-operatives in Warana Nagar, as a method of achieving socio-economic development. He showed how this could bring all the farmers together, to share information, increase productivity, and-profits. Thus was born the "Warna -Nagar Co-operative society". The society has a chairman and a Board of Members and is free from political influence and society members are free to elect the board members. There are about eight sub cooperative bodies, working under this main society viz.; Warna Dairy Development society, Warna cooperative Bank, Warna Foods, Warna Women's Co-operative society etc. Sugarcane is major crop of this area and of the sugar production of the two districts Kolhapur and Sangli is processed at this Society. From each village 200-300 farmers are registered as society members. The "Wired Village" project was initiated by Mr. Vinay Kore, the present Chairman of the Warna Co-operative Society in 1996, the actual implementation began in April 1998. The- Project has been jointly Implemented by GOI through National Informatics centre (NIC), Government of Maharashtra and Warna Co-operative Society with the share of financial support being in the ratio of 50:40:10. The manpower and maintenance cost are borne by the warna co-operative society itself'. The project area is a cluster of 70 villages consisting of 46 villages from Kolhapur and 24 villages from Sangli districts of Maharashtra.

This project has been initiated to serve the information needs on different crop cultivation practices of major crops, Sugarcane cultivation practices, pest and disease control, marketing information, dairy and sugarcane processing information etc' to the farmers right up to their village level. NIC, Pune was involved in setting-up the hardware and software and NIC, Delhi established connectivity of WAN links such as VSAT and dial-up connections. The software required for the system such as webpage designing, database designing and client based applications used by the farmers such as dairy, sugarcane information systems had been developed by the NIC, Pune.

The Central Hub, which is the main server station of "Wired Villages" is situated in Tahasaheb Kore Institute of Engineering Technology at Warana Nagar. This is equipped with servers based on Pentium II with 64 MB RAM, 4.1 GB hard disk and 32 x CD-ROM drives. The 64 kbps bandwidth VSAT connection has been established as a gateway WAN link to NIC, Pune for connecting into their network and into global network. This enables the main computer center to download information from NIC, Pune or the global network for latest information. The router is used to establish a WAN link to remote computer booths from the main computer centre, presently the router supports 10 simultaneous connections i.e. 10 users can access information at a time.

Computer Booths

For the farmers their villages, the Computer Booths are serving as information centers. The computer booth is operator by the booth operator and he is the main linkage between the farmers and information gateway center. The information sought relates to crops cultivation practices, land development, pesticides, diseases control details, marketing details, bills payments positions of sugarcane and dairy etc, currently forty-six computers. Booths are functioning in Kolhapur and meeting the information needs of the farmers. In remaining 24 villages of Sangli district, computer booths a hardware was setup, and are waiting to link to Central Server Station. Apart from information retrieval, there are two client-based applications, to serve the farmers needs. They are (1) Dairy Information system (2) Sugarcane Information System. In Dairy information System, the information on all the farmers, who are part of the dairy system, is maintained. Other details available to members of the dairy co-operatives include the quantity of milk supplied by each farmer, fat content, their billing information and credit details etc. This information is maintained and updated at the central database on daily basis. In Sugarcane Information System, information on shareholders is maintained. There are about 200-350 shareholders in each Village for sugarcane crop. This system maintains the details of the cultivation schedule; quantity harvested and supplied to the society, deductions effected by the Society towards credit, net income due to the farmers with respect to each shareholder. Every village is also linked with the Directorate of Marketing in Pune, which facilitates farmers in getting information on rates of vegetables, fruits and other crops. The Computer booths are provided with a Pentium II computer having 64 MB RAM, 2 GB hard disk, printer and an UPS power backup system. Dial-up connectivity with a modem and telephone line has been used to connect the main computer center to retrieve the information, send the queries, grievances to the central server station. The speed of dial-up connection is around 19200 BPS to 28000

BPS and average connectivity time is about 10 seconds: Telephone charge of around Rs 350/-, is paid by village level society.

Information Technology Centre

As much as six Information Technology Centres have been established to give training to staff, students and farmers of the village. These centers also function as computer booths and are maintained by a booth operator. The Centers have been provided with six Pentium II computers with configuration of Pentium II, 64 MB RAM, 2GB hard disk and a dot-matrix printer. Dial-up connectivity with modem and telephone line has been used to connect the central server station to retrieve information, send the queries, grievances to the main center. NIC, Pune has developed a Computer Based Question Bank, in the local language "Marathi" which will be used to test the Computer knowledge awareness of the students of 5th to 10th standard. These students are being trained to get acquainted with the computer systems. Testing will be in subjects covered in the school like mathematics, science etc. and a certain percentage of marks will be awarded from this test to the final marks of the students. A batch consisting of 5 students will be examined for 1 hour. This center also serves as a computer booth. NIIT is engaged in helping create CDs on different topics which when available will be used at these centres for interactive coaching.

Farmers' Feedback

An interaction with a few farmers in villages of Paragoam, Kuralap and Bhariwadi etc. indicated that farmers like the concept. They believe that the information from Wired Computers (WAN) is major source of getting information on crop technology. The ranking given by the farmers for source of information on crop technology, ranks wired computers as the best source followed by field officers and staff, radio & TV, print media and company sales persons. They agree that WAN provides all necessary information on cultivation technology and market situation etc., information is timely; the language is understandable as it is in the local Marathi language, information is reliable and it's not costly. They also agree that it is beneficial not only for big farmers but also for marginal and small farmers. The farmers are expecting some more features to be added like processing of all loan, legal documents etc. from their village wired computers. The farmers are also ready to learn operating computers, if any training is given and are ready to contribute any marginal amount necessary for the maintenance and up-keep of the system. Booth operators of paragoam, Bhairwadi, Kuralap and Panhala informed that an average of 20-25 farmers visit the computer booths every day for information on crop cultivation practices and disease control, marketing, dairy and sugarcane billing details etc.

(Sources: Case Study done by Bhaskar, G. Assistant Director (IT) and Venkateshwar Rao. K., Programmer, MANAGE, Hyderabad, in 2002, MANAGE. 2012. Information and Communication Technologies in Agricultural Information Management and Networking, Training module. pp1-30

The Internet for Information and Communication

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Now let's come across with the relevance of internet in ICT. We are in the midst of Information and Communication revolution. The world is rapidly shrinking to a 'global village', which some call a global family. In the merger of telephony, television and computers, a new world of Communications is evolving. What triggered this undreamt of merger is the emergence of Internet through which millions of computers and computer networks connected with each other exchanging information. The word Internet flashes many images upon the canvas of the mind. The applications aspect of Internet is the multitude of different services it offers, example' email, searching information over web, discussion groups etc. The Internet was started as a military network in USA and has undergone tremendous change over a period of time, offering variety of services to the users. The Internet is a huge resource of information that was accessed by millions of users every day, accounts to 100 terra bits of data passes through internet backbone for every minute. As per the ITU (International Telecommunications Union, www.itu.int website) Information, there were 1.13 billion subscribers to Internet in December 2006. India had 6.93 million subscribers and 60 million users of Internet. The Internet penetration figures (the percentage of population using internet) for various countries are interesting. The services and information that Internet provides are increasing at a very fast pace.

We know Internet is simply a worldwide network of computer networks. It is an open inter connection of networks that enables connected computers to communicate with each other. These networks are scattered over the globe, yet are interconnected making it possible to communicate with each other in a few seconds. Internet is not owned by any individual organization or the country; it is a free for all open service facility. It is governed by INTERNIC (Internet Network Information centre). The rise of Internet and the ease of use of Internet have been growing in parallel. Till the early 80's, using the Internet was a complex process of issuing text commands and remembering the complex numeric addresses of the communicating sites. However, its power was obvious. There was no other

method to connect up universities and research labs around the world that was so fast, convenient and flexible. The Internet users at universities came up with the software to participate in discussions over the network. They created documents and software libraries on the network, which were accessible to all users. During this period the Internet remained within the narrow confines of the academic and research lab world. Another development that fuelled the growth of Internet was the birth of Personal Computer or PC in the early 80's. Prior to that research and business, both used huge mainframes or minicomputers. With the prices of PCs coming down more and more, people across the world had their own computers. The demand for connecting these machines with each other gave birth to service provider agencies like Telenet and Computer Serve. Individuals could connect to them and communicate with other users on the same, for a fee. Further, on-line services came with the concept of Bulletin Board Service (BBS), in which individuals connect to another computer for exchange information and sharing software etc. Initially, these private networks, both corporate as well as commercial, had different hardware and software platforms and could not talk to each other, but very quickly, TCP/IP came to be used by them. Interconnection of these networks through TCP/IP gave birth to the Internet, as we know it today. All that is required to connect any network or computer with the Internet is the capability to use TCP/IP for exchanging the information.

History of Internet

Let's have a quick look into the background and genesis of Internet. The history of the Internet began with the development of electronic computers in the 1950s. The public was first introduced to the concepts that would lead to the Internet when a message was sent over the ARPANET from computer science Professor Leonard Kleinrock's laboratory at University of California, Los Angeles (UCLA), after the second piece of network equipment was installed at Stanford Research Institute (SRI). Packet switched networks such as ARPANET, Mark I at NPL in the UK, CYCLADES, Merit Network, Tymnet, and Telenet, were developed in the late 1960s and early 1970s using a variety of protocols. The ARPANET in particular led to the development of protocols for internetworking, in which multiple separate networks could be joined together into a network of networks.

In 1982, the Internet protocol suite (TCP/IP) was standardized, and consequently, the concept of a world-wide network of interconnected TCP/IP networks, called the Internet, was introduced. Access to the ARPANET was expanded in 1981 when the National Science Foundation (NSF) developed the Computer Science Network (CSNET) and again in 1986 when NSFNET provided access to supercomputer sites in the United States from research and education organizations. Commercial Internet service providers (ISPs) began to emerge in the late 1980s and early 1990s. The ARPANET was decommissioned in 1990. The Internet was commercialized in 1995 when NSFNET was decommissioned, removing the last restrictions on the use of the Internet to carry commercial traffic. Since the mid-1990s, the Internet has had a revolutionary impact on culture and commerce, including the rise of near-instant communication by electronic mail, instant messaging, Voice over Internet Protocol (VoIP) "phone calls", two-way interactive video calls, and the World Wide

Web with its discussion forums, blogs, social networking, and online shopping sites. The research and education community continues to develop and use advanced networks such as NSF's very high speed Backbone Network Service (vBNS), Internet2, and National Lambda Rail. Increasing amounts of data are transmitted at higher and higher speeds over fiber optic networks operating at 1-Gbit/s, 10-Gbit/s, or more. The Internet's takeover over the global communication landscape was almost instant in historical terms: it only communicated 1% of the information flowing through two-way telecommunications networks in the year 1993, already 51% by 2000, and more than 97% of the telecommunicated information by 2007. Today the Internet continues to grow, driven by ever greater amounts of online information, commerce, entertainment, and social networking. (Source: http://en.wikipedia.org/wiki/history_of_internet).

Internet as a technology is a tool of very recent origin. United State Department of Defense Advanced Research Project Agency (ARPA) funded its evolution as ARPANET in 1969. The initial intention was simple: to develop geographically dispersed, reliable communication network for military use, that would not be disrupted even in case of partial destruction. That aim was, accomplished by splitting the data being transmitted into small packet which can take different routes to reach their destination. The procedure developed for interconnecting ARPA net computers and communicating the data is called TCP/IP, i.e. Transmission Control Protocol/ Internet protect ARPA net was first confined to organizations and individuals having Government security clearance and working on government contracts. It soon merged with a non-governmental, parallel academic network called Usenet News, launched in 1979, which grew and eventually became known as the Internet. In the late 1980's the American Government through it's agency National Science Foundation (NSF) set up five computer centres, which became the main nodes of the Internet, to which the universities and research labs all over the world got connected. Later the NSF permitted commercial networks to be connected to Internet. In 1984, development of technology and the running of the network were turned over to private sector research and scientific agencies for further development. Now, the internet has emerged as one of the most powerful tools for global communication.

Two other important developments underline the present explosive growth of the Internet. The first took place at CERN, the European high energy physics lab near Geneva. There, in 1990, physicists developed software for publishing, searching and accessing information on the internet, as a way for scientists to share documents with their colleagues at large. This came to be known as the World Wide Web (www). The second occurred at the University of Illinois, where a young student named Marc Andersen developed a graphical browser called Mosaic, to access information from the www. These two developments have captured Internet from the laboratory to the mainstream of life. The use and growth of www has been even faster than the exponential growth of Internet.

Terms used with Internet World Wide Web (WWW)

The World Wide Web (abbreviated as WWW or W3, commonly known as the web) is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can view web pages that may contain text, images, videos, and other

multimedia and navigate between them via hyperlinks. The terms Internet and World Wide Web are often used in everyday speech without much distinction. However, the Internet and the World Wide Web are not the same. The Internet is a global system of interconnected computer networks. In contrast, the web is one of the services that run on the Internet. It is a collection of text documents and other resources, linked by hyperlinks and URLs, usually accessed by web browsers from web servers. Most web pages contain hyperlinks to other related pages and perhaps to downloadable files, source documents, definitions and other web resources. In the underlying 'HTML, a hyperlink looks like `Example.org, free encyclopedia` such a collection of useful, related resources, interconnected via hypertext links is dubbed a *web* of information. Publication on the Internet created what Tim Berners-Lee first called the *Worldwide Web* (in its original Camel Case, which was subsequently discarded) in November 1990.(Source: [http://en.wikipedia.org/wiki/World Wide Web](http://en.wikipedia.org/wiki/World_Wide_Web) cite note W90-6) The hyperlink structure of the WWW is described by the web graph: the nodes of the web graph correspond to the web pages (or URLs) the directed edges between them to the hyperlinks. (Source: [http://en.wikipedia.org/wiki/world wide web](http://en.wikipedia.org/wiki/world_wide_web)).

World Wide Web is a wide area, hypermedia information retrieval initiative aiming to give universal access to a large universe of documents. Hypermedia is a natural extension of hypertext, in that the contents of each document not only include text but also, images, sounds and video. WWW provides a consistent means to access a variety of information in a simplified manner to the users on computer networks. WWW contains a vast storehouse of hypertext documents written using the Hypertext Markup Language (HTML). Hypertext is a method for presenting text, images, sound, and videos that are linked together in non-sequential web of associations. Hypertext format allows the user to browse through topics in any order. WWW enables the users to view variety of information on any subject in the form of textual material, pictures, audio and videos. The information is also in the form of e-magazines, archives, public and university library resources, current world and business news. It provides a web of interactive documents that contain text, pictures, graphics, multimedia, animations, etc. The hyperlinks provide the links to the resources of the same page, other pages of the web site or the pages belongs to other web sites. The user can navigate through the information by pointing to special designated text or other objects on the screen. These objects link to the other WWW pages on the same server or any other WWW server on the network.

Web Browser

Let's see what a web browser is. A web browser (commonly referred to as a browser) is a software application for retrieving, presenting and traversing information resources on the World Wide Web. An *information resource* is identified by a Uniform Resource Identifier (URI/URL) and may be a web page, image, video or other piece of content. Hyperlinks present in resources enable users easily to navigate their browsers to related resources.

Although browsers are primarily intended to use the World Wide Web, they can also be used to access information provided by web servers in private networks or files in

systems. The major web browsers are Google Chrome, Mozilla Firefox, Internet Explorer, Opera, and Safari. Most major web browsers have these user interface elements in common:

- Back and forward buttons to go back to the previous resource and forward respectively.
- A refresh or reload button to reload the current resource.
- A stop button to cancel loading the resource. In some browsers, the stop button is merged with the reload button.
- A home button to return to the user's home page.
- An address bar to input the Uniform Resource Identifier (URI) of the desired resource and display it.
- A search bar to input terms into a search engine. In some browsers, the search bar is merged with the address bar.
- A status bar to display progress in loading the resource and also the URI of links when the cursor hovers over them, and page zooming capability.

Simply speaking, Web Browser is a software programme, which facilitates to access the information and presents it on the screen and helps in navigation on the internet. The browser provides with powerful and easy to use features that allow taking full advantage of web contents. The browser presents the formatted text, images, sound or other objects such as links in the form of web page on the computer screen. The web browsers also called as "Client" programmes, which takes commands from user and sends requests to "web server" to get information from it and presents it on the browser window. Web browsers give access to special multimedia contents that provide audio, video and interactive web pages. Web browsers were initially designed to interact with the content of World Wide Web. Most browsers now also interact directly with Gopher servers, FTP-sites and other internet tools and systems, thus providing a uniform, easy-to-use interface with many services of the Internet. Browsers can be divided into two basic groups: text mode and Graphic User Interface (GUI). Text-mode browsers are often faster and usable with a variety of hardware and software systems, but they have limitations as they can handle only text i.e. words. The Lynx is the most popular text-mode browser available on Unix based platforms. GUI browsers are easier to learn, faster to control and use. The GUI browsers can perform the same tasks as text-mode browsers. They are accomplished largely through mouse point-and-click operations in keeping with the native interface be it Windows, Macintosh, or X- Windows. The GUI browsers generally have some page-handling features like- the ability to save the page being viewed currently; print the page being viewed currently. Some browsers let you mail a page to yourself or someone else and some will even let you create and mail messages from within the browser. The leading browsers are Microsoft's Internet Explorer, Netscape Navigator and Fire fox.

Web page

A web page (or webpage) is a web document that is suitable for the World Wide Web and the *web browser*. A web browser displays a web page on a monitor or mobile device. The web page is what displays, but the term also refers to a computer file, usually written in HTML or comparable markup language, whose main distinction is to provide

hypertext that will navigate to *other* web pages via links. Web browsers coordinate web resources centered on the written web page, such as style sheets, scripts and images, to present the web page. On a network, a web browser can retrieve a web page from a remote web server. On a higher level, the web server may restrict access to only a private network such as a corporate intranet or it provides access to the World Wide Web. On a lower level, the web browser uses the Hypertext Transfer Protocol (HTTP) to make such requests.

A *static web page* is delivered exactly as stored, as web content in the web server's file system, while a *dynamic web page* is generated by a web application that is driven by server-side software or client-side scripting. Dynamic web pages help the browser (the client) to enhance the web page through user input to the server. Web pages usually include information as to the colours of text and backgrounds and very often also contain links to images and sometimes other types of media to be included in the final view. Layout, typographic and color-scheme information is provided by Cascading Style Sheet (CSS) instructions, which can either be embedded in the HTML or can be provided by a separate file, which is referenced from within the HTML. The latter case is especially relevant where one lengthy style sheet is relevant to a whole website: due to the way HTTP works, the browser will only download it once from the web server and use the cached copy for the whole site. Images are stored on the web server as separate files, but again HTTP allows for the fact that once a web page is downloaded to a browser, it is quite likely that related files such as images and style sheets will be requested as it is processed. An HTTP 1.1 web server will maintain a connection with the browser until all related resources have been requested and provided. Web browsers usually render images along with the text and other material on the displayed web page.

In simpler terms, a Web page is a single unit of information called a hypertext document. A webpage may consist of multimedia content such as text, images, sound and videos. A group of web pages created by one person or a company or organization is referred as web site. A hyper link can be used to link other documents, sounds, images, data bases, e-mail addresses etc. The links contained in web pages can point to areas within the same page, to other pages residing on the same web server, or to pages sitting on a computer on the other side of the world. Hyperlinks are usually underlined and are referred as URL. There is no need to know or type the URL. Each time the mouse moves over these links, the mouse pointer changes to a hand.

How does the Internet Work?

It is really interesting to learn how the Internet works. Internetworking is the practice of connecting a computer network with other networks through the use of gateways that provide a common method of routing information packets between the networks. The resulting system of interconnected networks is called an *internetwork*, or simply an *internet*. Internetworking is a combination of the words *inter* ("between") and *networking*; not *internet-working* or *international-network*. The most notable example of internetworking is the Internet, a network of networks based on many underlying hardware technologies, but unified by an internet working protocol standard, the Internet Protocol

Suite, often also referred to as TCP/IP. The smallest amount of effort to create an internet (an internetwork, not *the* Internet), is to have two LANs of computers connected to each other via a router. Simply using either a switch or a hub to connect two local area networks together doesn't imply internetworking; it just expands the original LAN. The definition of an internetwork today includes the connection of other types of computer networks such as personal area networks. The network elements used to connect individual networks in the ARPANET, the predecessor of the Internet, were originally called gateways, but the term has been deprecated in this context, because of possible confusion with functionally different devices. Today the interconnecting gateways are called Internet routers.

Yet another type of interconnection of networks often occurs within enterprises at the Link Layer of the networking model, i.e. at the hardware-centric layer below the level of the TCP/IP logical interfaces. Such interconnection is accomplished with network bridges and network switches. This is sometimes incorrectly termed internetworking, but the resulting system is simply a larger, single sub network, and no internetworking protocol, such as Internet Protocol, is required to traverse these devices. However, a single computer network may be converted into an internetwork by dividing the network into segments and logically dividing the segment traffic with routers. The Internet Protocol is designed to provide an unreliable (not guaranteed) packet service across the network. The architecture avoids intermediate network elements maintaining any state of the network. Instead, this function is assigned to the endpoints of each communication session. To transfer data reliably, applications must utilize an appropriate Transport Layer protocol, such as Transmission Control Protocol (TCP), which provides a reliable stream. Some applications use a simpler, connection-less transport protocol, User Datagram Protocol (UDP), for tasks which do not require reliable delivery of data or that require real-time service, such as video streaming or voice chat.

Actually there is no single central server or Computer or organization to make Internet work. All the Computers working independently, at various locations across the globe, are connected by the Internet. The information can be exchanged between these computers over the Internet, irrespective of the architecture of the hardware system, and operating system software working on the computers. It works because they follow the rules framed by the TCP/IP protocol (Transmission Control Protocol/Internet protocol). Because of heterogeneous computers and operating systems, a specific protocol is required, which can connect them into a common platform over internet to exchange the information easily. The TCP/IP is a standard protocol, which works with Internet. TCP/IP performs an important role when the data was sent by a computer. It breaks the data into smaller packets; each packet has three parts, the address where the packet is meant to go, and the data and error control information. The data packets will move to the destination in different paths with the help of the address. At the receiving end the packets were reassembled to get back to the original shape of data. There is no central computer or authority, instead of having the data gone to a central computer and then to its destination. Internet is dependent on the existing infrastructure developed by the telephone companies and Internet Service Providers (ISPs) to transmit the data. Internet service providers lease data circuits from the telephone networks and have dedicated computers at the data centres, network devices such as routers, firewall etc. These relay on the distributed intelligence of

networking equipment known as “Routers”. The content of internet is hosted on a computer known as “web server”. The web servers of data centre of ISP may be owned by the organizations, called as “Co-location” or certain space on the web server may be given to the organizations on lease to host the content. When a request is made of these servers for the information, they bundle the requested information in small packets, with address as to where it is to be sent, and send them to the nearest connection on the Internet. On the Internet, the packets are received by the router, which is nothing more than a traffic controller, and sent it down in the same general direction of the address. A similar thing happens at the next junction on the Internet. This goes on till the packet is-delivered to the right address, where it is put together again with other packets, to make up the original information. Say for example “you are sending a message from ICAR Head Quarters in Delhi to a server named google.com in USA. The message will be broken up into packets of approximately 1500 bytes, and some may travel from MTNL, Delhi ISP to the Google router in the US, some may travel to Hyderabad ISP and then to the Google router and so forth. There is no predetermined path and even individual packets of the same message may follow different paths. It all depends on the traffic at that node, at that moment in time. As the packets reach google.com, they are all put together as in the original message and delivered-to the given address.

Domain Names and Addresses

Let’s look into the terminology of domain name. A domain name (for instance, "example.com") is an identification string that defines a realm of administrative autonomy, authority, or control on the Internet. Domain names are formed by the rules and procedures of the Domain Name System (DNS). Any name registered in the DNS is a domain name. Domain names are used in various networking contexts and application-specific naming and addressing purposes. In general, a domain name represents an Internet Protocol (IP) resource, such as a personal computer used to access the Internet, a server computer hosting a web site, or the web site itself or any other service communicated via the Internet. Domain names serve as humanly memorable names for Internet participants, like computers, networks, and services. A domain name represents an Internet Protocol (IP) resource. Individual Internet host computers use domain names as host identifiers, or host names. Host names are the leaf labels in the domain name system usually without further subordinate domain name space. Host names appear as a component in Uniform Resource Locators (URLs) for Internet resources such as web sites (e.g., en.wikipedia.org).

Networks and computer systems on the Internet can communicate with each other. In order to communicate with each other, every computer on the Internet will be identified as a unique system like telephone numbers. All computers on the Internet have been assigned with an address system called IP address, which is unique number on Internet. These addresses are made up of a sequence of four three digit (decimal) numbers separated by periods. Eg: 164.100.140.2. Each number is in the range of 0 to 255. For example www.google.com is a domain name, which will be identified by the IP address 64.233.189.104. Because IP addresses are not easy to remember, computers are also identified by a name called domain name. A domain name server translates a domain name

into an IP address. This numeric scheme of IP addresses works well for computer systems, but it is difficult for people to remember and type correctly for every Internet site they need to contact. Therefore, Internet sites also have names associated with them. For example, ori.nic.in. Like the IP addresses, domain names are a sequence of words separated by periods. There are at least two words and can have three or more. The collection of networks making up the internet is divided into groups called domains. The domains represent type of organization and geographical location. For example a site in the domain 'edu' would be an educational institution. The domain name will give meaningful information to the users. For example www.nic.gov.in, which will tell that a web site named as 'NIC', owned by the government and belongs to India. An address specified as a domain name is automatically converted to the IP address. e.g. ori.nic.in IP address 164.100.140.2

List of Domains by Type of organization: A list of Domain name types used internationally is given here under:

Domain Type of Organization

.com	Commercial Origination
.edu	Educational Institution
.gov	Government (United States)
.org	Non-profit Organizations
.net	Networks

In India, Centre for Development of Advanced computing, Mumbai (formerly known as National Centre for Software Technology) is one of the Internet Domain Name Registrars. It regulates issue of domain names.

co.in	registered commercial organizations
ac.in	for academic community
res.in	for research institutes
gov.in	for government organizations
net.in	for network service providers
mil.in	for military establishments
org.in	for miscellaneous organizations

The indicator 'in' at the end of all the domain names above indicates that they are registered in India. For other countries there are different identifiers. A list of some well-known countries domain name indicators is given here under:

List of Geographical Domains

Domain	Country Name
.in	India
.au	Australia
.ca	Canada
.jp	Japan
.uk	United Kingdom

The two letter country code for all the countries is available at anonymous ftp site rtfm.mit.edu in the directory `/pub/usenet/news.answers/mail/` and on www at http://www.ee.ic.ac.uk/misc/country_code.html

Internet Connection

Internet access refers to the means by which users connect to the Internet. There are number of ways one can connect to the Internet. An Internet Service Provider (ISP) is a company that provides access to Internet. In general, there are two types of connections offered by Internet Service Provider. They are 1) Dial-up connection 2) direct indirect link (leased line or ISDN line).

Dial-up connectivity

The Dial-up connection is also known as Level Two connection. This provides connection to Internet through a dial-up terminal connection. The computer, which provides Internet access, is known as 'Host' and the computer that receives the access, is 'Client' or 'Terminal'. The client computer uses modem to access a "host" and acts as if it is a terminal directly connected to that host. 56K modem access is now widely available and supported by most ISPs. It allows user to surf the Web at 56 Kbps with graphics. So this type of connection is also known as 'Remote Modem Access' connection. And the host to which the client gets connected is actually connected to the Internet by a full time connection (See Leased Connection). In dial-up connection to Internet, Host carries all the command that are typed on a client machine and forward them to Internet. It also receives the data or information from the Internet on behalf of the 'Client' and passes it to them. The client computer acts as a 'dumb' terminal connected to remote host. This type of connection can further be divided into three categories.

Shell Connection: In this type of Internet Connection, the user will get only textual matter of a Web Page. This connection does not support Graphics display. Shell Accounts were the only type of Internet access available for many years before the Internet entered in to the world of graphics and became more user friendly.

TCP/IP Connection: Today's graphical World Wide Web browsers provide easier access with multimedia sound and pictures. The major difference between Shell and TCP/IP account is that, Shell account can only display text and does not support graphics display, whereas TCP/IP can display both.

ISDN: ISDN (Integrated Services Digital Network) offers Internet connectivity at speeds of up to 128 Kbps through the use of digital phone lines. ISDN is a dial-up service that has been provided by telephone companies for many years.

To access any of these dial-up accounts you need the following:

- Computer
- Modem
- Telephone Connection
- Shell or TCP/IP/ISDN account from the ISP
- Internet client software such as Internet browser

For smaller organizations, to establish link through a dial-up connection, computer calls to ISP over a telephone line. For instance, you might have a communication server on your network that calls the service provider to send and receive any Internet communications. The obvious advantage of service provider is that they are less expensive than establishing your own direct link with the Internet. The drawback is that the bandwidth is limited and the speed also depends on the number of connections accessing the same ISP.

Direct Internet Link

The direct Internet link can be provided in the form of leased line connectivity or ISDN connectivity by the ISP. In this type of connectivity, the organization router directly connects to the service provider with a higher bandwidth limit (64 kbps or 128 kbps or 256 kbps or 512 kbps or 1 mbps etc.) This type link is generally used by larger institutions, corporations and government agencies. It involves establishing internet gateway with a full-time link with the Internet for 24 hours/day. This type connectivity is beneficial to have the maximum traffic and throughput i.e. amount of data transferred with the Internet. The drawback, however, is the cost for band width.

Internet Services

Today the Internet is growing tremendously and is known mainly for the services it provides some of the best-known services available on the Internet including following:

- World Wide Web (www)
 - File Transfer Protocol (FTP) service
 - Electronic mail
 - Discussion groups and News Groups
- Let's see the glimpses of each service one by one.

World Wide Web

The term 'WWW' refers to the World Wide Web or simply the Web. The World Wide Web consists of all the public Web sites connected to the Internet worldwide, including the client devices (such as computers and cell phones) that access Web content. The WWW is just one of many applications of the Internet and computer networks.

The World Web is based on these technologies:

- HTML - Hypertext Markup Language

- HTTP - Hypertext Transfer Protocol
- Web servers and Web browsers

Researcher Tim Berners-Lee led the development of the original World Wide Web in the late 1980s and early 1990s. He helped build prototypes of the above Web technologies and coined the term "WWW." Web sites and Web browsing exploded in popularity during the mid-1990s. The World Wide Web (www) is the Internet's multimedia service that contains a vast storehouse of hypertext documents written using the Hypertext Markup Language (HTML). Hypertext is a method for presenting text, images, sound and videos that are linked together in a non-sequential web of associations. The hypertext format allows the user to browse through topics in any order. There are tools and protocols to explore the Internet. These tools help to locate and transport resources between computers.

File Transfer Protocol (FTP)

The 'File Transfer Protocol' (FTP) is a standard network protocol used to transfer files from one host to another host over TCP-based network, such as the Internet. FTP is built on a client server architecture and uses separate control and data connections between the client and the server. FTP users may authenticate themselves using a clear-text sign-in protocol, normally in the form of a username and password, but can connect anonymously if the server is configured to allow it. For secure transmission that hides (encrypts) the username and password, and encrypts the content, FTP is often secured with SSL/TLS ("FTPS"). SSH File Transfer Protocol ("SFTP") is sometimes also used instead, but is technologically different. The first FTP client applications were command line applications developed before operating systems had graphical user interfaces, and are still shipped with most Windows, Unix, and Linux operating systems. Dozens of FTP clients and automation utilities have been developed for desktops, servers, mobile devices, and hardware, and FTP has been incorporated into hundreds of productivity applications, such as Web page editors.

File Transfer Protocol (FTP) support is one method of supporting remote Networks. It is a protocol, which allows simple file transfer of documents. There are FTP servers, which provides vast amount of information stored as files. The data in these files cannot be accessed directly; rather the entire file must be transferred from the FTP server to the local computer. The most common protocol used for sending files between computers is the FTP, which allows for transferring both text and binary files. Both Microsoft operating systems and unix system include the traditional character based FTP client. This is one of the utilities that are copied onto the system when the TCP/IP protocol suit is installed. In addition, most Internet browsers such as Microsoft Internet Explorer, Netscape support FTP and use it behind the scenes when transferring files.

E-Mail

E-mail or the electronic mail is the most widely used application on the Internet for sending and receiving electronic messages. It is currently one of the most popular activities on the Internet. Most of the Internet users, have practically replaced other traditional

methods such as telephones, faxes etc. Technically E-mail is a system of delivery of messages on the computer connected via communication networks. E-mail is electronic version of paper mail or letters used to deliver personal and official messages. E-mail used to communicate all types of messages like text, graphics, audio and all visual clips as long as these can be digitized. Hence for all communication, needs e-mail that offers a quicker, cheaper and convenient option. To send e-mail, you must know the recipients' e-mail address. These addresses are composed of the user's identification, followed by the @sign, followed by the locations of the recipient's computer. For example, the e-mail address of an employee of MANAGE is name@manage.gov.in. The last three letters indicate this location is a government sponsored domain on Internet. When you access the Internet through a local service provider, you can exchange e-mail without incurring the long distance charges of telephone call. E-mail has the added advantage of allowing you to access messages at your convenience. You can also send an identical message any number of people at one time.

In government offices and research organizations, most of the communication with the international organizations like the World Bank, Food and Agricultural Organization, United Nations Development Programmers etc. is in form of e-mail. The largest users of e-mail, however, are the students of graduate and post graduate programmes in the universities. The students use e-mail as most efficient method of keeping in touch with their friends (in some other university in India or abroad), getting information on career and academic opportunities and also for seeking information on academic needs.

Discussion Groups and News Groups

Discussion groups and News groups also do have a vital role. Discussion Groups are the virtual networks of Scientists and other stake holders having email interactions/message postings on a common subject. Discussion groups undertake in-depth discussion on email mode. The emerging subject, issue is flagged by one of the group members and then email alert is sent to all the members. An agreed timeframe of one week to 10 days is decided for getting inputs from all the group members and responses are shared among all. Thus, highly focused discussions take place on the internet, without having any physical meeting. Discussion groups are emerging as one of the very effective scientific discussion forums on the internet. The solution exchange supported by United Nations Organizations (UNO) (website address : www.solutionexchange-un.net.in), has proved to be an excellent enabler of focused group discussions on highly topical issues like "Sustainable Agricultural Extension Systems", "Spreading the ICT Revolution, in Rural India- Experiences and Examples", "Establishing Rural Business Hubs" during last two years. Over 4000 experts and field managers have participated and contributed / benefited from the discussions. The consolidated responses on all these topics were later published for wider circulation. The solution exchange has organized its discussion forums in following groups: Food and Nutrition Security, Education, Environment, Gender, Health, Poverty, Aids, Decentralization, Disaster Management and ICT for Development. Each community (group) has over 1000 members and most of them contribute to take the discussions highly valuable and problem solving in nature. The community also shares latest developments in the concerned area and news about the emerging trends / issues in national and international arena. Discussion forums are also known as web forums, message boards,

discussion boards, (electronic) discussion groups, discussion forums, bulletin boards with a little variation in information Sharing mechanism. Essentially all these are tools for information-sharing on electronic-platform.

Search Engines and Searching

With over a thousand million pages and continuously increasing information in audio and video form on the World Wide Web, the task of finding precisely what you are looking for is very difficult. Search tools available on the internet make your search tasks easier. Many web based search, engines are available the search return the result of an internet search in a matter of seconds.

The Search Engines are powerful tools as they do the searching for you by following the instructions you give. Search engines search information on the World Wide Web. You need to supply the key words to the search engine and the search engine returns the index of pages, websites, where it finds match with your key words. The more detailed use of keywords, phrases with the combination of Boolean logic + (and), - (or) in your instructions, the more accurate the results will be. Some of the popular search engines are: google, yahoo, altavista, ask.com, gigablast.com, etc.

Agricultural Search Engines

The major search engines for Agriculture domain are:

1. www.agfind.com
2. www.agriculture.com
3. www.agricultureinformation.com
4. www.usagnet.com
5. www.farms.com
6. www.agcareers.com
7. www.produceindustry.com
8. www.usdareports.com
9. www.fruitsearch.com
10. www.producelinks.com

Almost all the above agricultural search engines are developed by US based companies and their focus is accordingly to serve their clientele. Hence, most of the information they search is US based/ hosted. In India as well as in other developing countries majority of the Agricultural scientists, extension Officials use generic search engines like Yahoo, Google, Alta Vista, Khoj etc.

How do Search Engines Work?

The World Wide Web has thousands of millions of pages on the net. You may wonder how your search engines browse through each of them and how does it return the information in such a little time? Secondly, why different search engines return different information for the same given key words? For example a search for the key words

"Agricultural Extension, India" returned 26,60,000 search results in 0.87 seconds on www.yahoo.co.in and the same search returned 21,20,000 search results in 0.15 seconds on www.google.co.in. Further only six out of first 1-10 of the results were common in both the lists. These questions will be answered once we understand how search engines work.

A search engine is a web-based application programme, which acts keywords/phrases submitted by the user. The search engines are support by a well developed database on keywords of web Content. The keywords are indexed and classified. When a user submits the keyword/phrases, the search engine submits to the database as query. The keywords will be searched in the database and the list matched will be returned to computer browser as a search results. The search results will contain a brief description of the word or phrase where it was found, web site address and a URL hyper linked, so that the user can jump to that particular page. There are basically two search methodologies, the search engines use. These are crawler based search methodology, example: google.com, and human powered directory based search methodology, example: yahoo.com. There are two more categories of search engines: combination search results of crawler based and also supported by human-power Dictionaries, example MSN.com, and Meta search engines, which query other search engines and return their top results, example: Ixquick, dog pile.

Crawler Based Search Methodology

Let's see the methodology of Crawler based search. The Crawler based search methodology has three steps or distinct parts. First: the crawler part of the search engine portal crawl, the web sites, i.e. the visit and re-visit the web sites on continuous basis. The "crawler" visits a web-site, reads all the pages (including all the links), and identifies the repetitions of certain words and phrases. The more number of times a word or phrase is found in the web-page or web-site, higher goes its possibility in the search results. Also the words or phrases found in the title of the website or Close to it have higher importance in the search results. The crawler submits these words, phrases to the second part of the search process- The Index. The Index holds all the words, phrases and their locations, with a hyper-link to their actual location, as index and a reference with brief details about the content of the web-site, for potential search query. The Index is giant catalogue which is built upon the information supplied, and updated by the crawler. The third and most important part of the search process is the actual search. The search engine searches the Index created by the crawler and returns the information which matches with the key words supplied by the user, in the order the search engine logic believes is the most relevant to the user. This logic is decided by the search engine development team. Normally top 10 results are returned by most of the search engines on the first return page.

Human-Powered Directory Based Search Methodology

In human-powered directory based search methodology, the web-site owner has to submit their website information including title and brief description to the Directory. For example, you can submit your site information to yahoo.com by simply clicking at "submit your site" hyperlink on yahoo.com search engine page. The directory is maintained by an editorial board at the search engine web-site. The information you submit is validated and

then sometimes edited by the Directory's editors. In the second step of this method, the search engine searches the Directory and returns the information which matches with the key words supplied by the user, in the order the search engine logic believes is the most relevant to the user.

Combination Search Results

Besides pure crawler based and pure Dictionary based search engines, there are some search engines which use a combination of both. For example, the "Live Search" of MSN uses the Look Smart listings. A search on Look Smart results from its own database and also from Inktomi submissions (Directory). Many search engines have agreements with other engines to use their results as primary or secondary listings.

Meta Search Engines

Meta search engine is a search tool that sends user requests to several other search engines and/or databases and aggregates the results into a single list or displays them according to their source. Meta search engines enable users to enter search criteria once and access several search engines simultaneously. Meta search engines operate on the premise that the Web is too large for any one search engine to index it all and that more comprehensive search results can be obtained by combining the results from several search engines. This also may save the user from having to use multiple search engines separately. The term "meta search" is frequently used to classify a set of commercial search engines, see the list of Meta search engine, but is also used to describe the paradigm of searching multiple data sources in real time. The National Information Standards Organization (NISO) uses the terms Federated Search and Meta search interchangeably to describe this web search paradigm. In brief, Meta search engines or Meta crawlers are those search engines that do not maintain their own listings or Directories but query other search engines for results. Examples of Meta crawlers are Ixquick, dogpile, excite.

Using Internet for Searching Agricultural Information

Really speaking, the face-to-face interaction among farmers, extension functionaries and the agricultural research scientists has been the most important process of Agricultural Extension in the developing countries, particularly in India. The system has been very effective and has delivered very good results in many situations. For example, during the Green Revolution period of late 60's, the fortnightly workshops among the farmers, extension functionaries and the agricultural research scientists under the "Training and Visit (T&V)" system were a huge hit and their impact on the production and productivity of major crops, particularly Paddy and Wheat were well documented. The uniformity of the "package of practices" and homogeneity of the farming situations were the main enablers in the Extension process during the early 70s'. Now, with focus to cover all Agro-eco-situations and including value addition and marketing issues as part of Agricultural Extension agenda, the process of Agricultural Extension has become complex. Alternative channels of

access to Agricultural Information have already overtaken the reach of public extension system in India. The access to modern agricultural technology was credited to Television by 9.3 % farmers and to Radio by 13 % of farmers as against only by 5.7 % of farmers to Extension Workers and only 0.7 farmers to the Krishi Vigyan Kendra's (KVKs), (Source: NSSO Report, Government of India, NSSO 2005).

Nowadays, the electronic media has already overtaken the traditional method of outreach. Now with increasing penetration of telephones and "Internet Cafes" in the rural areas the "Cyber Extension" is gaining momentum. There were over 26,000 Internet Kiosks in Rural India in 2006. The Government of India has already declared the "Common Service Centre (CSC)" Project, wherein 1,00,000 Common Service Centres were set-up under Public-Private Partnership mode (during 2007-2008). With this rural infrastructure in place, it is expected that majority of farming community will have access to Internet in very near future. The pilot projects taken up Dr. M.S. Swaminathan Research Foundation (MSSRF), Chennai in Pondicherry providing Internet based information services to 15 villages, by National Informatics Centre (NIC) connecting 45 villages under Warna Wired Village Project in Kolhapur and Sangli Districts of Maharashtra and by EID parry Ltd, in Cuddalore district of Tamil Nadu by giving Internet connectivity to over 70 Villages in the areas, have demonstrated that the Internet based information services are highly economical and serve the farmers at their door step. The farmers and extension functionaries are browsing the Internet to find the recommended "package of practices", best prices and markets for their produce and also meteorological data to take advance actions. The farmers are searching for the potential markets and customers for their produce not only in India but also overseas. Internet is thus emerging as one of the most important tools to search for Agricultural Information. At the same time, almost all the Agricultural Research and training institutions have started to host and enrich their web-sites with farmer-friendly information. For example, the website of Department of Agriculture Maharashtra www.agri.mah.nic.in is extremely farmer friendly and provides information on issues related to Government support to agriculture with complete information on development schemes, department plans, meteorological forecast and advisory to the farmers. The information is available in English and Marathi languages.

On the research side, almost all the ICAR Institutions have hosted their websites and are in process of putting their farmer-centric information on the sites.

Important Indian Agricultural Web Sites and portals

The addresses of some of the important (50 nos) Indian 'Agricultural Websites' are given below. (Source: MANAGE. 2012. Information and Communication Technologies in Agricultural Information Management and Networking, Training module. pp 1-30.)

1. www.agricoop.nic.in
2. www.indiaagrstat.com
3. www.isapindia.org
4. www.carrittmoran.com
5. www.fciweb.nic.in
6. www.fredisurti.com
7. www.indiancommodities.com

8. www.dare.nic.in
9. www.dacnet.nic.in
10. www.agmarknet.in
11. www.indiastat.com
12. www.manage.gov.in
13. www.icar.org.in
14. www.cazri.res.in
15. www.caie.nic.in
16. www.cifa.in
17. www.cife.edu.in
18. www.cpcri.ernet.in
19. www.dryland.ap.nic.in
20. www.crri.nic.in
21. www.iasri.res.in
22. www.iihr.res.in
23. www.spices.res.in
24. www.iisr.nic.in
25. www.nianp.nic.in
26. www.nbagr.ernet.in
27. www.nbfgr.res.in
28. www.nbpgr.ernet.in
29. www.nbsslup.nic.in
30. www.ncap.res.in
31. www.nrcaf.ernet.in
32. www.nrccashew.org
33. www.nrce.nic.in
34. www.iari.res.in
35. www.nrcgrapes.mah.nic.in
36. www.nrcipm.org.in
37. www.nrc-map.org
38. www.nrcmashroom.org
39. www.nrccig.mah.nic.in
40. www.nrcjowar.res.in
41. www.nrcsoya.com
42. www.nrcws.org
43. www.iimahd.ernet.in
44. www.itcibd.com
45. www.esagu.in
46. www.agri.mah.nic.in
47. www.nird.ap.nic.in
48. www.emandi.mla.iitk.ac.in
49. www.nafed-india.com
50. www.iffco.nic.in

Trends in Agricultural Information Management: Web 2.0 and Social Networking

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Examining the recent trends Agricultural Information Management, it can be observed that, the advances in technologies, particularly Internet technologies have changed the way information is accessed and disseminated. There is a shift towards more dynamic applications and more interactivity between users. This current shift in web technologies is commonly known currently as Web 2.0. As internet technology has evolved from Web 1.0 to Web 2.0, the manner in which information is generated, accessed, organized, and disseminated has changed. Some of the attributes of Web 2.0 include the growth of social networks, bidirectional communication and significant diversity in types of content. Web 2.0 as a term used to describe websites and services where the content is created partially or entirely by the users. The term Web 2.0 was conceptualized and introduced by Tim O'Reilly and Dale Dougherty. Tim O'Reilly defined web 2.0 as: "the business revolution in the computer industry caused by the move to the internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them" (O'Reilly, 2006). Wikipedia defines Web 2.0 as "a second generation of services available on the World Wide Web that let people collaborates, and share information online.." (Source: <http://en.wikipedia.org/wiki/Web2.0>.)

The Web 2.0 describes websites that use technology beyond the static pages of earlier web sites. The term was coined in 1999 by Darcy DiNucci and was popularized by Tim O'Reilly at the O'Reilly Media Web 2.0 conference in late 2004. Although Web 2.0 suggests a new version of the World Wide Web, it does not refer to an update to any technical specification, but rather to cumulative changes in the way web pages are made and used. A Web 2.0 site may allow users to interact and collaborate with each other in a social media

dialogue as creators of user-generated content in a virtual community, in contrast to websites where people are limited to the passive viewing of content. Examples of Web 2.0 include social networking sites, blogs, wikis, folksonomies, video sharing sites, hosted services, web applications, and mashups. Whether Web 2.0 is substantively different from prior web technologies has been challenged by World Wide Web inventor Sir Tim Berners-Lee, who describes the term as jargon. His original vision of the Web was "a collaborative medium, a place where we all meet and read and write ([http://en.wikipedia.org/wiki/Web 2](http://en.wikipedia.org/wiki/Web_2)).

Similarly the Web 2.0 also provides opportunities for interaction, collaboration, networking, and sharing. While in web 1.0, there were relatively few content creators, with web 2.0, any user can be a content creator with the number of tools made available for content creation. Web 2.0 is based on user centered applications that promote communication, user empowerment, collaboration and social networking. Web 2.0 also allows exchange of different kinds of content and makes it also possible to combine content resulting in new information products. Web 2.0 tools are increasingly being used in research and development work, to share knowledge, collaborate, discuss, plan, manage, implement etc. The use of Web 2.0 tools within the development sector is still in its infancy. Some of the examples of the use of Web 2.0 applications in the development sector include use of Internet/SMS gateways to distribute information to people with access to mobile phones but no access to internet. These users can also post through SMS to blogs and online databases. Content aggregators enable users to quickly find the information they are searching for, without having to navigate through a number of websites.

There have also been attempts to use these new web tools in the agricultural sector. An international conference on "Web2ForDev" was organized by the Consultative Group on International Agricultural Research (CGIAR), in 2007. The objective was to explore ways in which development stakeholders could take advantage of the opportunities provided by Web 2.0 methods, approaches and applications to further improve networking, information exchange and collaboration for rural and agricultural development and natural resource management (Web 2.0 for Dev, 2007). The term "Participatory Web 2.0 for development" or Web2forDev was first used at this conference. The conference provided an opportunity for people and organizations from around the globe to share knowledge and experiences of the use of Web 2.0 tools in and for development. The conference highlighted how these new web tools have changed traditional patterns of communication and knowledge sharing. Web2forDev is a way of using the web, to improve information sharing and collaborative production of content in the context of development work.

The Web 2.0 services are more user-centered, with focus on collaboration and interactivity. Users can respond to what they read, and contribute content, thus adding more information. A Web 2.0 Website may include a number of Services viz., Blogs, RSS feeds, Wikis, Podcast, Tags etc. Web 2.0, allows the Content to be reused and remixed in different ways by different services. It is possible to select and subscribe to the knowledge of others and then recombine this knowledge into other services. The same content may be shared through different devices viz., PC, mobile phone, PDA or iPod- Using Web 2.0 applications one can be a content creator through blogs; collaborate on wikis, share images through flickr, recommend sites through tagging or connect on my space and more. A

number of organizations have begun using the web to create, exchange, share knowledge and information and to communicate, collaborate and disseminate development content.

Web 2.0 Tools

The Web 2.0 tools include Blogs, RSS, Wikis, Flickr, social networking tools etc. Some web 2.0 tools are briefly profiled here with examples of application in agriculture, by organizations around the world.

Blogs

One of the major tools of Web 2.0 is a blog. Blog which is short for "web log," is a site where contributors can post news, thoughts, comments, reflections etc. Wikipedia defines a blog as "a Web site, usually maintained by an individual with regular entries of Commentary, descriptions of events, or other material such as graphics or video." It is an online journal or web site on which articles are posted and displayed in chronological order. Subject resources, book reviews, library news, discussion groups etc.

Blogging software:

- <http://wordpress.com>
- <http://www.livejournal.com>
- <http://www.blogger.com>

A blog is a discussion or informational site published on the World Wide Web and consisting of discrete entries ("posts") typically displayed in reverse chronological order (the most recent post appears first). Until 2009, blogs were usually the work of a single individual, occasionally of a small group, and often covered a single subject. More recently "multi-author blogs" (MABs) have developed, with posts written by large numbers of authors and professionally edited. MABs from newspapers, other media outlets, universities, think tanks, interest groups and similar institutions account for an increasing quantity of blog traffic. The rise of Twitter and other "micro blogging" systems helps integrate MABs and single-author blogs into societal new streams. Blog can also be used as a verb, meaning to maintain or add content to a blog.

The entries in a blog are commonly displayed in reverse-chronological order. Many blogs provide commentary or news on a particular subject; others are personal online diaries. A typical blog combines text, images, and links to other blogs, web pages, and other media related to its topic. A key feature is that it allows people to post comments to another person's blog. People can subscribe to each others' sites, and easily link to individual comments on a page. Apart from this, through a mechanism called trackbacks, they can see when anyone else links to their pages, and can respond, either with reciprocal links, or by adding comments. One can also subscribe to new posts in a blog using RSS. (O'Reilly, 2008). The potential of Blogs has been recognized by a number of development organizations including, Technical Centre for Agricultural and Rural Cooperation (CTA), AFD, Overseas Development Institute (ODI), World Bank, etc. CTA has a number of blogs at <http://announcements.ctq.int> to publish news and announcements; interact with CTA communities at <http://neun.cta.int>; publish and disseminate reports. <http://brusselsbriefings.net>, and one related to policy developments <http://brussels.cta.int>. ICRISAT's blog at <http://blog.icrisat.org/kmsblog/> alerts to contents pages of journals,

articles, and other news. The Virtual Academy for the Semi Arid Tropics (VASAT) has a blog at <http://vasatblog.icrisat.org/> which posts new developments and news from VASAT. The International Food Policy research institute (IFPRI) has set up a number of blogs: some of which include Blog World Hunger, which is an open global food and nutrition security diary that aims to identify and analyze alternative national and international strategies and policies for meeting world food needs. (www.ifpriblog.org).

Kisan Blog, an audio blog in Hindi at <http://opaals.iitk.ac.in:9000/kisanblog/index.php> is an initiative by Deal India, conceived by IIT Kanpur and funded by Media Lab Asia. Users can post their entries and comments through an audio device. Farmers can submit questions via voice mail, and experts' answers are published on the website as audio files. All communication is in Hindi, the local language of the farmers. The user can record his question or comment in an electronic device or directly through a microphone attached to a computer linked to the Internet. The user has to log on into the page for posting a query. Each participating Agricultural Science Centre has been allotted a separate login identity to validate their identity. Once a user logs in to the page he can post his/her query directly or upload a file already recorded on an electronic device. After the recording is done, the user can check the same for quality, clarity etc. It is automatically stored at the server of DEAL. Administrator validation is required for the message to be on air. The filtering is usually done by the agricultural experts of DEAL to ensure validity of the questions asked and the answers provided. (GTZ, 2008).

Once on air, the query appears on the blog site with a title, identity and the audio. Users interested in answering the query can click on the option "number of suggestions". The same recording method is followed to answer a query. The names of the most recent users who provide suggestions along with associated information related to their designation, expertise, etc' are categorized and appear at the top of the Kisan Blog. This ensures authenticity of the suggestion as well as gives recognition to the person. Apart from institutions many individuals have also set up blogs to exchange knowledge. The web site www.technorati.com/search/agriculture gives access to blog on agriculture. It is very easy to set up a blog, customize and update quickly. Some of the providers may be accessed at www.blogspot.com and www.wordpress.com.

RSS

RSS is the acronym used to describe the de facto standard for the *syndication of Web content*. RSS is an XML-based format and while it can be used in different ways for content distribution, its most widespread usage is in distributing news headlines on the Web. A Web site that wants to allow other sites to publish some of its content creates an RSS document and registers the document with an RSS publisher. A user that can read RSS-distributed content can use the content on a different site. Syndicated content can include data such as news feeds, events listings, news stories, headlines, project updates, and excerpts from discussion forums or even corporate information. Because there are different versions of RSS, the term RSS is most frequently used as a name to mean the *syndication of Web content*, rather than as an acronym for its founding technology. When using the name RSS the speaker may be referring to any of the following versions of Web content syndication:

RDF Site Summary (RSS 0.9, RSS 1.0)

Rich Site Summary (RSS 0.91, RSS 1.0)
Really Simple Syndication (RSS 2.0)

When using the term RSS, most will use it in reference to *Rich Site Summary* or the previous version called *RDF Site Summary*. When referring to *Really Simple Syndication*, it will usually be called RSS 2.0, not RSS. There are several versions of RSS available, with the most commonly implemented version being RSS 0.91. The most current version, however, is RSS 2.0 and it is backward-compatible with RSS 0.91. RSS was originally developed by Netscape. The RSS 2.0 specification was authored by Dave Winer (Source: www.webopedia.com).

News readers or news aggregators help. These are software programs which help bring information from sites of interest to the user. These news aggregators check each site to see if they contain RSS (Rich Site Summary) tags. RSS is a method of summarizing the latest news and information from a website in a form that can be easily read by news readers or news aggregators. The idea is to give users the ability to quickly obtain the latest news and updates from a site in a headline or news digest format.

RSS (Rich Site Summary); originally RDF Site Summary; often dubbed *Really Simple Syndication*, uses a family of standard web feed formats to publish frequently updated information: blog entries, news headlines, audio, video. An RSS document (called "feed", "web feed" or "channel") includes full or summarized text, and metadata, like publishing date and author's name. RSS feeds enable publishers to syndicate data automatically. A standard XML file format ensures compatibility with many different machines/programs. RSS feeds also benefit users who want to receive timely updates from favorite websites or to aggregate data from many sites. Once users subscribe to a website RSS removes the need for them to manually check it. Instead, their browser constantly monitors the site and informs the user of any updates. The browser can also be commanded to automatically download the new data for the user. Software termed, "RSS reader", "aggregator", or "feed reader", which can be web-based, desktop-based, or mobile-device-based, present RSS feed data to users. Users subscribe to feeds either by entering a feed's URI into the reader or by clicking on the browser's feed icon. The RSS reader checks the user's feeds regularly for new information and can automatically download it, if that function is enabled. The reader also provides a user interface. (Source: www.wikipedia.org)

Why use RSS and who should use RSS

RSS was designed to show selected data. Without RSS, users will have to check your site daily for new updates. This may be too time-consuming for many users. With an RSS feed (RSS is often called a News feed or RSS feed) they can check your site faster using an RSS aggregator (a site or program that gathers and sorts out RSS feeds). Since RSS data is small and fast-loading, it can easily be used with services like cell phones or PDA's. Web-rings with similar information can easily share data on their web sites to make them better and more useful. Webmasters who seldom update their web sites do not need RSS! RSS is useful for web sites that are updated frequently, like:

- News sites - Lists news with title, date and descriptions
- Companies - Lists news and new products
- Calendars - Lists upcoming events and important days
- Site changes - Lists changed pages or new pages(www.w3schools.com)

In simpler terms, RSS stands for Really Simple Syndication or Rich Site summary. It is an XML-based format for syndicating Web content that helps viewers decide whether they want to follow the link. Syndicated content may include news feeds, listing of events, news stories, headlines, project updates, excerpts from discussion, forums etc.: Webopedia. RSS feed contains headlines, summaries and links to full news stories and allows users to link not just to a page, but to subscribe to it to be updated with a notification every time that page changes. Thus subscribers can receive automatic updates (on the web or by email) whenever the particular content is updated. Thus, instead of a user having to repeatedly visit favorite websites to check for new content, RSS notifies about updates. As the number of RSS feeds, making it difficult to identify and select relevant feeds, RSS Aggregators help by aggregating RSS feeds and allow the user to scan headlines from a number of news sources in a central location. Aggregators combine RSS feeds into new feeds, for e.g. all agriculture related news from several news feeds can be combined and a new feed provided. While some RSS aggregators, such as Bloglines, are web-based, others are desktop clients, and others allow users of portable devices to subscribe to updated content. Web-based feed readers and news aggregators require no software installation and make the user's "feeds" available on any computer with Web access. Some RSS readers are Bloglines <http://bloglines.com/>; Newz Crawler [www.newzcrawler.Com](http://www.newzcrawler.com); Feed Reader www.feedreader.com; RSS Reader <http://www.rssreader.cod>; Net Newswire <http://ranchero.com./netnewswire/> etc. Lists of RSS readers can also be accessed at Google and Yahoo. RSS is now being used to push data updates, including market prices, weather information, etc. Many websites now offer RSS feeds. The Global Forum on Agricultural Research (GFAR) offers news feeds at www.egfar.org/egfar/website/new/ from several other sources. CTA has launched a 'news4dev' aggregator at www.newsfordev.org that takes content from different collections and repositories and enable readers subscribe to different RSS feeds. FAO, GFAR, IAALD and others have also set up an aggregator at www.agrifeds.org where feed publishers can submit their feeds, and readers can sign up for feeds that interest them. ODI's Update news feed at <http://www.odi.org.uk/news/feeds.asp> gives the latest Information from ODI, alerting whenever new content is added to the ODI website.

WIKIS

Let's now see what is Wiki? It is the *simplest online database that could possibly work*. Wiki is a piece of server software that allows users to freely create and edit Web page content using any Web browser. Wiki supports hyperlinks and has simple text syntax for creating new pages and cross links between internal pages on the fly. Wiki is unusual among group communication mechanisms in that it allows the organization of contributions to be edited in addition to the content itself. Like many simple concepts, "open editing" has some profound and subtle effects on Wiki usage. Allowing everyday users to create and edit

any page in a Web site is exciting in that it encourages democratic use of the Web and promotes content composition by nontechnical users. (Source: wiki.org)

Wikis are Web pages or sites that can be edited and maintained by several people. One of the best examples is Wikipedia. at <http://en.wikipedia.org/wiki>. Wiki is "a page or collection of Web pages designed to enable anyone who accesses it to contribute or modify content, using a simplified markup language" - Wikipedia. Wikis are also used to create collaborative websites. This Wiki is an interactive and collaborative website. Registered users can add tools and methods, content, edit existing pages, insert comments and anecdotes. Documents can be written collaboratively, in a simple markup language using a Web browser. A single page in a wiki website is referred to as a "wiki page" while the entire collection of pages, which are usually well interconnected by hyperlinks, is "the wiki".(Wikipedia). Many wikis are open to alteration by the general public without registering. Some wikis however need user authentication for adding content, editing or even reading pages. A wiki can be used for project management and can allow people in several Organizations to update progress.

15 Productive Uses for a Wiki

1) To-do list. Once you've learned the simple wiki markup language, creating a list is easy. And the most productive list, of course, is the to-do list. In fact, if you're into GTD, you can set up multiple context lists for a simple GTD system-try GTD Tiddlywiki, dcubed, or Monkey GTD for more integrated wiki solutions.

2) Project management. A wiki can be a great way to plan and manage a project, from conception to completion. Assign tasks, make a timeline, and add notes, paste images and other media – whatever you need for a project, there's no simpler way to organize it all.

3) Operations manuals. If you've got a company full of web workers, it doesn't make sense to have a hardcopy or server-hosted version of a manual – put it online, so that it can be updated when things change, so that anyone can view the updated version at any time. Things change so quickly these days that a printed version of a manual is outdated as soon as it's printed and distributed.

4) Checklists. Have a process that's repeated often? If so, create a checklist so you never forget anything, and it's done right every time. Put it on your wiki, and never forget where it is.

5) Plan an event. Conferences, weddings, off-site meetings, parties and events of all kinds have been planned with wikis, because they're perfect. Multiple people can access the plans, you can create different sections for different planning areas, create checklists, add notes, ideas, images, contact info, and much more.

6) Log client work. If you do a lot of freelancing, like I do, you know that you need a system of logging your work: either hours spent on a project or number of projects completed (articles written, in my case), along with dates, rates and other notes. There are many tools for doing this, but one of the simplest is adding it to your personal wiki. You could have all your client logs on one page, or create a separate page for each client – the flexibility of a wiki is why it works so well.

7) Track invoices. Similarly, you also need to track your invoices to each client: the work done, dates, rates, etc., along with when the invoices were submitted, when they're due, and

when they were paid. Again, there are other services for this, but if you are already putting your logs on your wiki, why not add your invoice tracking in the same place?

8) Notes and snippets. Web workers take notes, pull snippets from pages, save images all the time and yet it can be hard to keep track of all of them. Keep them all in one place on a wiki for easy access when you need them.

9) Goals. This can be a work thing or a personal thing, or both, but one of the problems with our goals is that we might write them down, but we might also then forget about them. If you make your personal wiki your place to go for everything, be sure to put your goals here: along with action steps, deadlines, progress reports, notes, etc. Get your life in gear on your wiki.

10) Contacts. Still haven't found a great online solution for your contacts? If you use your wiki a lot, it can be an easy and quick way to add contacts and find them any time and any place you need them.

11) Workspace. If you use multiple computers, and need a place to do your work that you can access from anywhere, a wiki isn't a bad choice. Besides being a place to keep your notes and snippets and images together, you can write articles, reports, etc. and keep everything together. You don't need to do the actual writing here, if that's not your preference, but it can be where you keep the writing or other work and related items.

12) FAQs. If you get a lot of questions about your work, or product, or just about yourself personally, you can keep an ever-growing FAQ to prevent having to repeat your answers too many times. Then just point people to your FAQ url.

13) Collaboration. There are more fancy, complicated or expensive options for collaborating on something with people in spread out locations, but probably not many things as simple and easy as a wiki. Again, you can work on a project or even just one document with another person or group of people the entire Internet, in fact, if you want to get global. Changes are made and tracked, and you can revert to previous versions if necessary.

14) Reference. Got a list, document, codes, instructions, etc. that you need to refer to regularly? Keep it here on your wiki, so you never have to go looking again.

15) One place for everything. One of the best reasons to have a wiki is because it can do all of the above, and more. It's versatile: more so than most other tools on the web: which means that whatever you need to do, the wiki can accommodate. And that allows you to keep everything in one place: which is the key to staying organized. Otherwise, you'll have things all over the place, and you'll have to remember where they are, or you'll forget about them. Keeping things all in one place is a great way to keep productive.

The CGIAR has put up a wiki with training materials for the tools and methods being taught for its course on knowledge sharing in agricultural research at (<http://kstoolkit.wikis.cgiar.org>). The Virtual Academy of Semi Arid Tropics (VASAT) Wiki is an attempt to build a Repository of Re-usable Information objects in Agricultural Education and Extension and is being used for educating and supporting rural women and men across vast geographical areas by informing them about good agricultural practices to drought and desertification. (VASAT, 2006).

Similarly, agropedia is an online agricultural knowledge repository that makes agricultural information available to specialists, researchers, extension personnel and the agricultural community, and allows them to search and make contributions to the vast

knowledge base. The key elements of the system are knowledge models and objects in the form of text, image, audio and video. Knowledge is disseminated in several languages to users who have been categorized as anonymous, authentic users and editors. This agropedia incorporates Web 2.0 elements such as agro-wiki, agro-blog and commentary spaces for interaction and has more than 7,400 registered users. The content in agropedia is aggregated and organized through the use of knowledge models. Knowledge models have been standardized for nine crops. This article covers the role of agropedia for agricultural knowledge transfer and extension services. (Source: agropedia: An ICT Application for Agricultural Knowledge Transfer and Extension, Ankur Kukreja SRF, IARI, New Delhi ankur.kukreja85@gmail.com)

Agropedia, an agricultural Wikipedia at <http://agropedia.iitk.ac.in/> has been launched in January 2009 by scientists in India as an online repository of agricultural information in the country. This is envisaged as a platform where specialists in agricultural research and education and students and those interested in agriculture can contribute to the knowledge base. Specialists can also participate in the agrowiki, agro-blog, agro-forum and agro-chat. The objective is to disseminate crop and region specific information to researchers, agricultural extension workers, students and farmers. The website currently has information on nine crops. The project is being implemented under the National Agricultural Innovation Project (NAIP) and is funded by the World Bank and the Government of India. (Agropedia' 2009)

Sharing Images

Agricultural researchers and extension managers often depend on photographs to document plants, pests, diseases, etc. Web 2.0 tools like Flickr can help organize and share photos and images easier. Flickr at www.flickr.com and Picasa at www.picasa.com allow photos and images to be shared. Flickr is a social photo sharing site where users can upload their photos and share them as well as receive comments from other users. Users can tag their photos to locations, people or events. IRRI uses Flickr to upload and share its photos. (www.flickr.com/photos/ricephotos/sets). A user can also subscribe to another user's photo stream via RSS.

Common photo sharing tools

Flickr (stylized as flickr and pronounced "flicker") is an image hosting and hosting website, and web services suite that was created by Ludicorp in 2004 and acquired by Yahoo! in 2005. In addition to being a popular website for users to share and embed personal photographs, and effectively an online community, the service is widely used by photo researchers and by bloggers to host images that they embed in blogs and social media. (Terdiman, Daniel (2004-12-09). "Photo Site a Hit With Bloggers". *Wired*. Retrieved 2008-08-28.)

Picasa is an image organizer and image viewer for organizing and editing digital photos, plus an integrated photo-sharing website, originally created by a company named Life scape (which at that time may have resided at Idea lab) in 2002 and owned by Google since 2004. "Picasa" is a blend of the name of Spanish painter Pablo Picasso, the phrase *mi casa* (Spanish for "my house") and "pic" for pictures (personalized art). In July 2004, Google

acquired Picasa from its original author and began offering it as freeware. (Lifescape's Picasa aims to be your digital "shoebox". By Michael R. Tomkins, the Imaging Resource (Monday, November 18, 2002 - 15:49 EST). Published on imaging-resource.com under "Comdex Fall 2002 Show")

Smug Mug

The Smug Mug is a premium photo sharing web site with an emphasis on professional photography. That's not to say that the site's not also perfect for the weekend photographer, as its attractive and user-friendly interface is tempting for any level of photographs. The biggest hurdle for new Smug Mug users is that the site has no free account (though there is a 14 day free trial), and the minimum price for an account is \$40/year. However, Smug Mug users: many of whom are former Flickr die-hards (there's even an import tool called Smugglr): seem very pleased with their choice.

Photobucket

Once upon a time, Photobucket was a favorite among internet users looking to quickly host an image and share it online at sites like eBay and MySpace or on blogs and message boards. While that's still true, Photobucket has added several features to keep users coming back to the site for managing photo albums and videos. (lifehacker.com)

Sharing Videos

You Tube is a video-sharing website, created by three former PayPal employees in February 2005 and owned by Google since late 2006, on which users can upload, view and share videos. The company is based in San Bruno, California, and uses Adobe and HTML5 technology to display a wide variety of user-generated video content, including movie clips, TV clips, and music videos, as well as amateur content such as video blogging, short original videos, and educational videos.

Most of the content on YouTube has been uploaded by individuals, although media corporations including CBS, the BBC, Vevo, Hulu, and other organizations offer some of their material via the site, as part of the YouTube partnership program. Unregistered users can watch videos, while registered users can upload an unlimited number of videos. (Source: Hopkins, Jim (October 11, 2006). "Surprise! There's a third YouTube co-founder". *USA Today*. Retrieved November 29, 2008.) For sharing videos, one can access YouTube www.youtube.com, www.blip.tv and <http://video.google.com/>. YouTube is a social networking site where users can upload and share videos. This may include instructional videos, extension materials and other agriculture related videos. The videos can be edited and uploaded easily. These services also allow comments, feedback and sometimes rankings from visitors. They provide RSS feeds and automatic subscription options so that a visitor can be updated when new content of their interest is published.

Marketing information on Mobile

Reuters Market Light (RML):

Reuters Market Light (RML) was launched in October 2007 by Thomson Reuters group. It was intended to provide farmers with agricultural market price information, weather as well as crop advisory information via the mobile phone. The service launch was preceded by an 18 month market research, concept tests and market trials. The information available via their service is localized, Thus each subscriber gets information pertinent to his location and/ or subscription parameters. Hence a subscriber will get market prices from the mandis he has subscribed for and for the commodities that are of interest to him. RML currently tracks prices for 250 commodities across 1,000 mandis (with 195 in Maharashtra). In addition, weather and crop advisory information is also location specific. They provide weather forecast for nearly 2,500 locations. The mode of delivery is via SMS. Provided that their handsets allow it, it is possible to get the SMS in the local language. For example, users in Maharashtra can get their SMS alerts in either English or Marathi. RML, a business incubated by Thomson Reuters, is a pioneering mobile phone-based agri information service provider. The service is designed to provide farmers with personalised timely and actionable agricultural information from pre-sowing to post-harvest stages through SMS on their mobile phones in their local language. About 1 million Indian farmers from an estimated 50,000 villages have used this service across 17 states. Through sharing among farmers, it is estimated to have reached 5 million farmers. At present, RML is available in 13 states in India, covering over 450 crop and crop varieties and more than 1300 markets. With this service, individual farmers gained up to INR 2,00,000 (\$ 4000) of additional profits, and savings of nearly INR 4,00,000 (\$8000), marking a significant return on their investment. (Source: Winners of 2010 World Business and Development Awards". International Chamber of Commerce.www.google.in)

S.No	Name of Service Provider/VAS Provider	State (District)
1	Tata Tele Services Limited	Uttar Pradesh (Gautam Buddha Nagar)
2	Sasken Communication Technologies Limited	Tamil Nadu (Kanyakumari and Coimbatore), Kerala (Thrissur)
3	Reuters Market Light	Maharashtra (Pune)
4	Reuters Market Light	Uttarakhand (Almora, Bageshwar, Tehri, Uttarkashi and Chamoli)
5	Unitech Wireless (Tamil Nadu) Private Limited	Tamil Nadu (Vellore and Thiruvannamalai)
6	Videocon Telecommunications Limited	Tamil Nadu (Cuddalore, Thanjavur, Pudukotai, and Dindigul) and Puduchchery (Puduchchery)
7	Vodafone Essar South Limited	Andhra Pradesh (Warangal and Rangareddy)

8	Bharti Hexacom Limited	Rajasthan (Ajmer)
9	Reuters Market Light	Maharashtra (Amravati)

(Source: Ministry of Communication and Information Technology Department of Telecommunication Universal Service Obligation Fund www.usof.gov.in)

RML's operation spans 8 states with most of the offices engaged only in content collection, production and aggregation. The service itself is available in Haryana, Punjab and Himachal Pradesh in addition to Maharashtra and Goa. They have had to employ their own dedicated price collectors for the mandis that they cover. However, weather, crop advisory information as well as local news are generally obtained via agreements and partnerships with third party sources, which are both private as well as state level institutions. Currently RML operates on a direct-selling approach whereby users buy scratch card which enable them to register for the service for a specific amount of time. Currently this service is network agnostic in all the states where RML operates and they utilize a bulk SMS service provider to push messages to users, irrespective of the telecommunication network they are subscribed to. However as it expands to other states, it has left open the possibility of other delivery mechanisms. Users who subscribe for this service have 4 possible packages that they can choose from, dependent on the timeframe for which they subscribe. When the service first debuted in 2007, users in Maharashtra could only buy a one month subscription for INR 60. This was quickly expanded to include packages for 3 months (INR 175), 6 months (INR 350) and 12 months (INR 650). They have also explore different price points and in Haryana and Punjab (which are predominately agricultural states), the 3, 6 and 12 month packages cost INR 250; INR 550 and INR 850 respectively. According to RML, the initial trend was towards purchasing 3 month subscriptions. But over time 6 and 12 month subscriptions are the most popular. RML currently reports the average subscription to be about 5.5 months.

IFFCO Kisan Sanchar Ltd.

The Mobile operator Bharti Airtel partnered with IFFCO to form a joint venture company in 2008, to provide 5 free daily voice updates on mandi prices, farming techniques (including dairy as well as animal husbandry), weather forecasts, rural health initiatives and fertilizer availability, etc. mainly targeting the 55 million farmers who are members of IFFCO. As of the date of this report they are now active in the states of Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Rajasthan, Uttaranchal, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu and West Bengal. Airtel currently reports having signed-on 1.5million subscribers for this service from these 18 states. The service is marketed as part of specialized mobile tariff package only on Airtel's network with an IFFCO Kisan branded SIM card. IFFCO is a co-operative institution having more than 40,000 co-operative societies as its members and base of 60 millions farmers. The farmers are owners of IFFCO through the share contribution of their respective societies and also the consumer as they use fertilizers produced by IFFCO's various plants to grow the food grains. apart from distributing the quality fertilizers to the farmers though their respective cooperative societies, IFFCO is also educating the farmers by organizing different promotional activities so that farmers are acquainted with the latest

technology in agriculture and also are able to use the best of the agriculture inputs to grow more food for the country, as well as, get a better income from farming.

Aim / Vision / Mission

- To empower farmers and people living in rural India with pertinent and high quality information and services, through affordable communication network, in a sustainable manner.
- To work concertedly to develop content and services which will improve informed decision making by people living in Indian villages.

Mandi on Mobile

The BSNL, the national state owned Telecommunications Company and On Mobile a Private-sector VAS provider partnered with the Uttar Pradesh Agricultural Marketing Board (Mandi Parishad) in late 2008 to start a service called "Mandi on Mobile." The service allowed BSNL subscribers to call a number and receive current market prices of about 108 commodities, from all the 247 mandis in the state. The completely voice-based solution (which even accepted voice commands) solution, allowed farmers to just enter the commodity and the district and would get current taluka-wise mandi rates for the chosen commodity in the specified district. The project was started out as pilot and to-date hasn't expanded beyond the state, even though Bharti has since then partnered with others to start a similar pilot in other states. (Lokanathan, Sriganesh & de Silva, Harsha (2010). Leveraging Mobile 2.0 in India for Agricultural Market Access, March 2010, I DRC and DFID.)

Some ICT initiatives

aAQUA (Almost All Question Answered)

'Almost All Questions Answered' or aAQUA is a Farmer Knowledge Exchange available at aaqua.org answering questions from progressive farmers in 4 languages in any one of 420 districts in India and some places abroad. aAQUA, is an online question answering website providing farm and veterinary advisory services to farmers over phone or internet. A panel of experts assesses the problem through a set of images or text posted by the affected farmer, work out feasible solutions and send back recommended solutions through the online forum. Phone help-lines augment the online service. Any farmer, agriculturist or hobbyist can register and post questions and a panel of Agriculture Experts answers questions based on the problem description and photos if any. Contextual Information such as geographical location, weather, and season are retrieved automatically and made available to experts. Apart from agriculture, aAQUA is a forum for questions regarding education, healthcare and other issues important to a developing population. Currently questions may be asked in one of four languages- Hindi, Marathi, Kannada and English.

Having originally developed at the Developmental Informatics Lab, aAQUA uses relational database management systems and information retrieval techniques with query optimization, intermittent synchronization and multilingual support. An excellent technical introduction is available in the Internet Computing Article (1, Sahni, Saurabh; Krithi Ramamritham (2007). "Delay tolerant applications for low bandwidth and intermittently connected users: the aAQUA experience". ACM New York, NY, USA. 2, Ramamritham, Krithi; Anil Bahuman, Saurabh Sahni, Malathy Baru, Chaitra Bahuman, Arun Chandran, Manjiri Joshi (2008). "The aAQUA Approach: Innovative Web 2.0 Tools for Developing Countries". IEEE Educational Activities Department.)

An online, archived, web based discussion forum, which allows users to create, view and manage content. It provides retrieval of contextual information, documents and images using various keyword search strategies with the help of query expansion and indexing techniques. Using this, a farmer can ask a question on aAqua from a kiosk; experts view the question and answer back, providing solutions to the problem. aAQUA has been deployed at many kiosks in Pabal and Rajguru, Shirur, and Haveli taluka region in Maharashtra. It is available in English, Hindi, and Marathi. Being Unicode compliant system, it can support other languages also. It has been developed at Media Lab Asia research hub at IIT, Mumbai. (Source: Link: <http://www.aaqua.org>)

AGMARKNET

Agricultural Marketing Information Network (AGMARKNET) was launched in March 2000 by the Union Ministry of Agriculture. The Directorate of Marketing and Inspection (DMI), under the Ministry, link around 7,000 agricultural wholesale markets in India with the State Agricultural Marketing Boards and Directorates for effective information exchange. This e-governance portal AGMARKNET, implemented by National Informatics Centre (NIC), facilitates generation and transmission of prices, commodity arrival information from agricultural produce markets, and web-based dissemination to producers, consumers, traders, and policy makers transparently and quickly. The AGMARKNET website (<http://www.agmarknet.nic.in>) is a G2C e-governance portal that caters to the needs of various stakeholders such as farmers, industry, policymakers and academic institutions by providing agricultural marketing related information from a single window. The portal has helped to reach farmers who do not have sufficient resources to get adequate market information. It facilitates web-based information flow, of the daily arrivals and prices of commodities in the agricultural produce markets spread across the country. The data transmitted from all the markets is available on the AGMARKNET portal in 8 regional languages and English. It displays Commodity-wise, Variety-wise daily prices and arrivals information from all wholesale markets. Various types of reports can be viewed including trend reports for prices and arrivals for important commodities. Currently, about 1,800 markets are connected and work is in progress for another 700 markets. The AGMARKNET portal now has a database of about 300 commodities and 2,000 varieties. (Source: <http://agmarknet.nic.in/index.html>, <http://www.Agricoop.nic.in>)

Actually, as a step towards globalization of agriculture, the Directorate of Marketing & Inspection (DMI) in India has embarked upon this ICT project: "NICNET

based Agricultural Marketing Information System Network (AGMARKNET)" for linking all important APMCS (Agricultural Produce Market Committees), State Agricultural marketing Boards / Directorates and OMI regional offices located Throughout the country, for effective information exchange on market prices NIC implements this project on a turn-key basis. (Source; Link:www.agmarknet.nic.in, Subject: Market information, wholesale markets).

Chalao Ho Gaon Me

Community Radio Program '*Chalao Ho Gaon Mein*' initiated by Alternative for India Development in the regions of Palamau, Garhwa and Latehar districts of Jharkhand completed its 500th episode on 18th May 2007. The programme was first aired on 5th August 2001 from AIR Daltonganj. Since then it has accomplished a milestone in the annals of community radio broadcasting in India. A single community based sponsored program in India from any AIR station has completed its remarkable 500 episodes without any external or internal disturbance. Its greatest achievement have been the participation of grassroots communities in making their own radio program by giving voice to local governance and social issues through local dialects.

As community radio program '*Chalao Ho Gaon Mein*' was initiated by Alternative for India Development in the above 3 districts of Jharkhand, it was a weekly community radio program aired on AIR. Two local NGOs 'Alternatives for India Development(AID)' and 'Manthan Yuva Sangathan' joined hands to launch *Chalao Ho Gaon Mein*, a half- hour community broadcast on All India Radio. An NGO, AID, and journalists lend technical support to the programme Manthan. The National Foundation for India (NFI), strategically and financially backs the initiative. Every Sunday at 7.20 p.m. AIR Daltonganj broadcasts the sponsored program Chala Ho Goan Mein (30 min.). The local dialect of Maghi is used in the program to the maximum extent. A range of Issues of local importance are broadcast on the radio every week which has brought in value addition. The villagers are involved in designing and devising the concepts and themes for the program. Programme development, message gathering and analysis and pre-editing listening session are carried out every month during a creative workshop. The content is decided after equal participation of all. For the first time, villagers from this area are participating in a community initiative and are getting to hear their own voices on the radio. (Source: Alternative for India Development, 2008).

DACNET

DACNET also possesses significant attention in ICT initiative. It is a scheme for bringing E-Governance in the Directorates and Field Units of Department of Agriculture & Cooperation (DAC). The project is being executed by National Informatics Centre (NIC) to facilitate Agriculture-on-line. The goal of NIC is to deliver coherent and integrated solutions (best practices, experiences and global solutions) that enable the Department to establish online Agricultural Information to farmers using ICT. In order to bring e-governance and to establish an Intranet for all the offices of DAC, NIC will facilitate the Directorates and it's field units to be connected and have access to information. NIC's focus is on increasing value in the Department of Agriculture and Cooperation (DAC) and enhancing its

relationships with its minimum agenda of e-governance: Integration of Government Functions (G2G), Integrating Agri-Business Partners (B2B), Connecting Farmers (C2C), Empowering Employees, Enhancing Government productivity and value and financial services.

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DACNET will include

- Establishing e-Business infrastructure
- To implement various e-Governance solutions and make it as showcase for other Government Departments to follow
- Achieving the minimum agenda of e-Governance
- Developing e-Governance application packages
- Integration of Government functions (G2G)
- Enhancing Government productivity
- Portal (<http://dacnet.nic.in>) to facilitate dissemination of information
- Decision support for planners
- IT Empowerment of the officials of the Directorates/Attached/Subordinate and the Field Units
- Usher in e-Governance which could even eventually facilitate Agriculture-on-line
- (www.datasmarth.com) Link: www.dacnet.nic.in, Subject: e-governance, online agriculture

Digital Green

Digital Green combines technology and social organization to improve the cost-effectiveness and broaden the community participation of existing agricultural extension systems. By building on existing social linkages and using technology, Digital Green seeks to amplify the impact of agriculture extension workers who help farmers become more productive.

Digital Green records live demonstrations of agricultural practices by experts, transmit them to a large database and distribute them on DVDs to local organizations for dissemination among small and marginal farmers. Digital Green uses low-cost and portable technology viz. camcorders, TVs and Pico projectors for the production and dissemination of videos. Videos are based on content identified by the community, feature local farmers, are created in local dialects, and are duly checked for accuracy by agricultural experts. These screenings are mediated by an expert to help farmers adopt the practices as well as monitor their status after adoption. Digital Green partners with local organizations which are already working

on agricultural extension programmes. Currently, it is operating in 5 states and partners with 7 organizations. With more than 1650 videos in its database and a reach over 58,000 farmers, Digital Green today is ten times more effective, per dollar spent, in converting farmers to better farming practices than traditional approaches to agricultural extension.

In nut shell, *Digital Green* is an agricultural training and advising system that seeks to benefit rural farmers by disseminating targeted information through digital videos and phones. Pilot experiments in the field began in September 2006 through an NGO, called Green Foundation, which promotes sustainable farming practices in southeastern Karnataka. They are compiling a repository of videos that includes testimonials of progressive farmers, field demonstrations led by agri-scientists, interactions amongst farmers, and Market-based opportunities. (Source: [indiagovernance.gov.in/best practices](http://indiagovernance.gov.in/best_practices). Link : [http : //www. digitalgreen. org/](http://www.digitalgreen.org/) Subject: Digital video, cell phone, sustainable farming, content delivery)

Digital Mandi

Digital Mandi by Media Lab Asia is an electronic trading platform for agro commodities. The idea is to connect dispersed village level primary mandis (spread across the country), and mills through a nationwide web based Interactive marketing platform. This can facilitate speedy and efficient information dissemination for better price discovery and risk management to actualize vision of National Commodity Exchange. (Link : [http : //www.digitalmandi. net](http://www.digitalmandi.net), Subject: Web-based, electronic market, information dissemination)

e-krishi

The 'e-Krishi' is a Market Driven Agricultural Initiative through IT enabled Agri Business Centres in Kerala State implemented by Kerala State IT Mission (KSITM) & Indian Institute of Information Technology & Management Kerala (IIITM-K) in collaboration with Department of Agriculture. The vision of the project is to establish a connected farmers' community throughout Kerala who have access to information on Market Demand, Prices, Good Agricultural practices, Quality Agricultural Inputs supported by a technology Enabled robust transaction platform that facilitates all their offline activities. The need to integrate activities from policy making to grass root implementation requires a platform incorporating various Government Departments and other stakeholders. The key output from the initiative shall be the facilitation and integration of economic activities of all member stakeholders involved in Agriculture thus enabling conversion of under-Performing and non- performing agricultural farms into high yielding farms of quality products in demand.

Objectives of the initiative

- (i) Aggregation of responsive farmer community of about 1,00,000 with a cumulative farm land of 1,00,000 hectares cultivating priority crops as determined by the market demand

- (ii) Enrolment of buyers in key markets including manufacturers
- (iii) Enrolment of agricultural input providers : seeds, plantlets, fertilizers, pesticides, technology/methodology providers/consultants, test laboratories and so on.
- (iv) Warehousing facility providers
- (v) Enrolment of Logistics services support providers
- (vi) Enrolment of banks & insurers
- (vii) Legal, accounting, documentation support
- (viii) Enrolment of establishment of a robust IT enabled platform where the members can seek information, transact and make or receive electronic payments. (Source: Link: www.e-krishi.org, Subject: Information services, markets, rural community)

E-Krishi, the market driven agricultural initiative through IT enabled agri-business center in Kerala state addresses the existing gap in agriculture information flow and transaction management. The vision of the project is to establish a well connected farmer's community throughout Kerala who have access to information on market demand, price, good agricultural practices, quality agricultural inputs supported by a technology enabled robust transaction platform that facilitates all their offline activities. The project is piggy backed on the existing resources of Akshaya e-kendras for providing the services. The project was piloted in Malappuram district in 2006 and was funded by UNDP/NISG. Now it is operational in Kasaragod, Kannur, Kozhikode and Kollam districts with the help of Department of Agriculture and Local Self Government Institutions.

Benefits to Member Farmers

- Access to markets with prevailing price information and ensuring correct price for their products
- Access to schemes, subsidies, modern agricultural methods, best practices, soil testing, seeds, plantlets, fertilizers and pest control
- Facilities for grading agricultural produces
- Logistics support and cost sharing possibilities
- Access to micro credits
- Agri-insurance support/faster claim processing
- Access to accounting practices and documentation support (e-krishi.org)

e-Krishi Vipanan

The e-Krishi Vipanan (EKVI) project, the e-Agriculture Marketing project of Government of Madhya Pradesh, India, is conceived and executed by Madhya Pradesh Agricultural Marketing Board (Mandi Board) and Madhya Pradesh Agency for Promotion of Information Technology (MAP-IT), on Build, Own, and Operate basis with a Consortium of vendors where in the vendors on Public -Private -Participation model to make operations effective and transparent by collecting and disseminating real time information, on-line and

help the concerned stakeholders in effective decision making, which will eventually lead to grainless mandis. Vendors are paid a percentage of fees collected by the Agricultural Marketing Yards. EKVI Project involves use of ICT for automation of Mandi Board Head Office, 7 Regional Offices, and 231 Mandis and their associated Sub-market yards and Nakas (Interstate barriers), across the State of Madhya Pradesh. Most of the Mandis and Sub Mandis are located in villages having 6 million Farmers with 70,000 licensed traders.(Source: Link: e-Krishi Vipanana, Subject: Market information, decision making, rural, Madhya Pradesh, India).

Regulated agricultural markets or 'mandis' in Madhya Pradesh, India are set to revolutionize the very system of agricultural marketing. Gone are the days when a farmer used to come to the mandi and was forced to sell his crop even when he knew that the crop was not being valued correctly. Now a farmer is empowered with the information that enables him to make informed decisions as to when and where to sell. In other words, now he can decide on the mandi where he wants to sell his crop, even demand more prices in the same mandi, or refuse to sell at all if not given the right price. All this has been made possible by the unique initiative called e-Agricultural marketing or e-krishi Vipanana (EKVI), which arms the farmer with the information of prevalent rates in mandis. And this is just the beginning. The project has a sweep of benefits for all stakeholders: farmers, traders, mandis, and the government. The EKVI Project involves automation of the Mandi Board Head Office, seven regional offices, 229 mandis and their associated sub-market yards and Inter-state border check posts i.e. 'nakas' across Madhya Pradesh in India. The data generated at mandis with regard to agricultural produce, sale, etc. is captured 'online' through Smart Card terminals, transferred to computers in mandis, and transmitted on a communication network to the associated Regional Office and Head Office via VSAT. This information is then accessible at specified nakas (and a few other points) for verification of documents on a 24/7 basis.

Benefits to the Farmers

- Availability of latest information on rates, arrivals etc. in various state mandis.
- Choice to decide when and where to sell
- Facilitate contract farming
- Sell the produce from doorstep through e-trading
- Reduction in losses due to transportation & handling

Benefits to the Traders

- Transparent procedures
- Single window disposal
- Reconciliation of daily sales, accounts, transit permit
- Availability of rates in various mandis would help in offering better rates to farmers
- Transportation losses reduced due to e-agricultural marketing

Benefits to the mandis

- Instant reconciliation of accounts, transit permits, receivables and payables.
- Effective monitoring of activities
- Facilitates implementation of contract farming

- Ensures transparency in operations

Benefits to the Government

- Speedy collection, analysis and dissemination of information
 - Improved tax revenue collection by collation of valuable data.
 - Instantaneous access even to remote locations through VSAT connectivity.
- (Source: <http://egov.eletsonline.com/>)

e-Sagu: IT based Personalized Agricultural Extension System

The e-Sagu also has a considerable relevance. The project 'Building a Cost Effective and Personalized e-Sagu' aims to develop e-Agri Clinic models for providing personalized agricultural advice to farmers for the major crops such as paddy, cotton, maize, chilli, castor, redgram, ground nut and aquaculture. The project is providing personalized advice to about 5000 farmers in more than 30 villages in Andhra Pradesh. A revenue model is also being implemented in the project. Value added services viz. making available appropriate pesticides and fertilizers, credit facilities, storage and marketing etc. are being integrated. This has been taken up by IIIT, Hyderabad. Ministry of Agriculture, NGOs, industry, and farmers are participating in this project. (Source: Link': [http://www.esagu.in/esagu/Subject: Farmer education, personalized advice, revenue model](http://www.esagu.in/esagu/Subject:Farmer%20education,%20personalized%20advice,%20revenue%20model))

An IT based personalized agricultural information dissemination system has been developed by the International Institute of Information Technology, Hyderabad to deliver agricultural expert's advice afresh in a personalized manner to each individual farmer at his door steps. In contrast to the existing method of agricultural expert visiting the crop to diagnose and deliver an effective advice, the crop environment comes to an expert team of agricultural scientists in the form of digital photographs and associated text images to the central office at Hyderabad. The expert team which includes scientists of all relevant disciplines analyzes the crop situation with respect to soil, weather and related parameters to formulate an effective advice. The advice thus developed will be immediately available on the internet along with name and ID number of the farmer and farm respectively. But the advice reaches the door steps of the resource poor farmers with the help of a co-coordinator specially trained for this purpose at the village computer centre. The system as a prototype has successfully been tested at Oorugonda, Gudeppad and Oglapur villages in Atmakur mandal of Warangal district in Andhra Pradesh state during Kharif season, 2004 on cotton crop. The system contains four components viz. farmers, coordinators, agricultural experts and an information & communication system that operate asynchronously. (Source: ijedict.dec.uwi.edu).

i-Shakti

The Project Shakti is an initiative of Hindustan Unilever Limited (HUL) to usher prosperity and uplift the standard of living in rural India. The objectives are to create, income-generating capabilities for underprivileged rural women by providing a small-scale enterprise opportunity, and to improve rural living standards through health and hygiene awareness. A key factor that has inhibited the development of rural India has been lack of access to critical information and services. Given India's large geography and weak

Infrastructure, it is often difficult to reach out to the rural areas. In order to Impact both livelihood opportunities and living standards of rural Communities 'i-Shakti' -an IT-based rural information service has been developed to provide information and services to meet rural needs in agriculture, education, vocational training, health and hygiene. The premise of the 'i-Shakti' model is to provide need based demand driven information and services across a large variety of sectors that impact the daily livelihood opportunities and living standards of the village community. To catalyze overall rural development, HUL hopes to collaborate with mainstream institutions (both corporate and not-for-profit organizations) that are experts in agriculture, health, insurance, financial services and education.

The service is now available in Nalgonda, Vishakapatnam, West Godavari and East Godavari districts. By the end of the year, HUL hopes to cover 1000 i-Shakti kiosks across the state. In brief, the i-Shakti service is an extension of HUL's Project Shakti, which creates income-generating capabilities for underprivileged rural women by providing a sustainable micro enterprise opportunity, and to improve rural living standards through health and hygiene awareness. Started in Andhra Pradesh in 2001, Project Shakti has already been extended to about 20,000 villages in 196 districts in Andhra Pradesh, Karnataka, Gujarat, Madhya Pradesh, Tamil Nadu, Chattisgarh, Uttar Pradesh, Orissa, Punjab, Rajasthan, and Maharashtra. HUL's vision for Project Shakti is to scale it up across the country by 2005, creating about 25000 Shakti entrepreneurs, covering 100,000 villages, and touching the lives of 100 million rural consumers. (Source: <http://www.hul.co.in> Subject: Information service, rural communities, enterprise development)

Kisan Call Centers

The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India launched Kisan Call Centers on January 21, 2004 across the country to deliver extension services to the farming community. A farmer can call a toll free number 1551 or 1800-180-1551 and get instant access to information. The purpose of these call centers is to respond to issues raised by farmers, instantly, in the local language. There are call centers for every state which are expected to handle traffic from any part of the country. Queries related to agriculture and allied sectors are being addressed through these call centers. The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India launched Kisan Call Centers on January 21, 2004 across the country to deliver extension services to the farming community. The purpose of these call centers is to respond to issues raised by farmers, instantly, in the local language. There are call centers for every state which are expected to handle traffic from any part of the country. Queries related to agriculture and allied sectors are being addressed through these call centers.

A farmer from any part of the State can contact the Kisan Call Centre by dialing the toll free Telephone No. and present their problems/queries related to farming. The operator at the Kisan Call centre will attempt to answer the problems/queries of the farmers immediately. In case the operator at the Call Centre is not able to address the farmer's query immediately, the call will be forwarded to identified agricultural specialists. For Meghalaya, the Agriculture Information Officer and the Horticulture Officer, Department of Agriculture are currently the designated specialists

(Source: Link: <http://www.manage.gov.in/kcc.htm>, Subject: Extension delivery, call center. <http://megagriculture.gov.in>)

KISSAN- Kerala Project

Karshaka Information Systems Services and Networking (KISSAN) is an Innovative project by the Department of Agriculture, Government of Kerala. This project for agriculture is a pilot implementation of application of IT through relevant Information Systems and networking to aggregate, share and disseminates information of importance and interest to the farmers, agriculture workers and officials in ways that enhance the total agriculture development and farmers' welfare in the state. The objective is to provide an effective knowledge management and smart information dissemination system that provides linkage among farmers, public research institutions, administrative and private entrepreneurs to share the information and knowledge.

KISSAN is an integrated, multi-modal delivery of agricultural information system, which provides several dynamic and useful information and advisory services for the farming community across Kerala. It is one of the leading citizen centric e-governance projects of the Department of Agriculture, Govt. of Kerala. The project was conceived, developed and managed by the Indian Institute of Information Technology and Management- Kerala for the Department of Agriculture, Govt. of Kerala. The basic objective of this project is to provide "Right Information to the Right Person(s) at the Right Time in the Right Place(s) and in the Right Context" dynamically using a combination of advanced technology like Web Technology, Television based mass media programs, Telephone based advisory, Mobile SMS based advisory and broadcast service, dedicated online Agri video channel provides video on demand service etc, which, involves effective collaboration of experts from key organizations for effective information delivery and knowledge empowerment on demand seamlessly to all farmers across Kerala. (Source: Link: [http : /www. kissankerala. net/home.jsp](http://www.kissankerala.net/home.jsp), Subject: Information technology, communication technology, development, communication, community building)

Kunjai Pachae Kutch Ji community radio project by Kutch Mahila Vikas Sanghathan (KMVS)

This is a partnership between Kutch Mahila Vikas Sanghathan and the Dhrishti Media Collective. Place is Kutch district of Gujarat and target Group is Women in Kutch villages, which essentially focuses on empowerment of women for panchayat functions through the Media: AIR MW station at Bhuj.

Namma Dhwani - Karnataka

In Budikote a village 100 km from Bangalore, on the Karnataka and Andhra Pradesh border, Namma Dhwani is India's first cable community radio station. It is the result of a partnership between the rural communities in Boodikote; MYRADA, an NGO; VOICES, a development-oriented Communications organization and UNESCO. The infrastructure was provided by MYRADA, the technical expertise from VOICES and the funding was from UNESCO' Representatives of Self Help Groups form the Namma Dhwani Management committee (NDMC) and are the chief planners and implementers of the service, and the coordination is by staff from MYRADA and VOICES. Community radio was perceived as a source for timely and useful local information and for sharing their experiences and

problems with other community members. The community used their radio station to complain about non-functioning water services and the problem was addressed by the authorities.

It has benefitted individual villagers as well. Programmes have been made on a variety of topics including sericulture, organic farming and health. This not only improved the knowledge base but also involved the members more closely in the development of their community. In order to reach the local community the community radio staff started narrow casting at self help meetings. Resource people were drawn from the community to talk about selected topics and interviews were recorded on tape. Programmes were played at community meetings, in schools, at youth groups, during training programmes and at the local market. The network was extended to 60 Self Help Groups consisting mainly of women from poor families who had little access to information, in 35 villages around Boodikote. This became a group activity, providing ample scope for discussion.

Pastapur Community Media Centre in Zaheerabad, Medak district

This is a partnership between the Deccan Development Society (DDS), an NGO in Pastapur. Owners and audience are women's groups (sangams) in 75 villages of Medak district. The initiative is managed by women who record programmes by interviewing local experts, editing and making the content ready for broadcasting. The station works on the audio cassette technology. The programme content seeks to meet the information, education, and cultural needs of the region. Programmes relate to information specific to agricultural needs of semi-arid regions, education and literacy, health and hygiene, environmental issues, food security, indigenous knowledge systems, issues related to women empowerment local cultures, with emphasis on the narrative traditions of song and drama. The content includes agricultural practices, animal husbandry, horticulture, medicinal plants, seed preservation systems and methods, government schemes, revival of customs and traditions. Format is both spoken and musical: interviews in the studio or on the field with local experts, discussions (in the form of questions and answers), interviews, plays, storytelling, burra kathas, rela patalu (agricultural practices). (Source: DDS, 2008).

TARAhaat

TARAhaat is a Development Alternatives, a sustainable development enterprise established in 1983 as a not for profit research, development and action organization. TARAhaat's vision is to empower people to achieve their aspirations by using Information and Communication Technology (ICT). (source: Link: www.tarahaat.com, Subject: Enterprise development, information services)

Tata Kisan Sansars

Tata Kisan Sansars are one-stop resource centres that offer cultivators a wide range of services and solutions from the stage of sowing of seeds to post-harvest management and marketing of agricultural produce. The Tata Kisan Sansar network reflects the Tata Group's belief that technology can and must be harnessed to solve India's social and economic

problems. The concept of precision farming being implemented by the TKS has the potential to catapult rural India from the bullock-craft age into the new era of satellites and IT. At the helm of this endeavor is Tata Chemicals Limited (TCL), the Standout chemicals and fertilizers company in the Tata Group. TCL's extension services, brought to farmers through the TKS, use remote-sensing technology to analyse soil, inform about crop health, pest attacks and coverage of various crops predicting the final output. This helps farmers adapt quickly to changing conditions. The result: healthier crops, higher yields and enhanced incomes for farmers. Staff members at each sansar are equipped to find solutions to every agriculture-related problem. A well stocked library of journals and magazines helps farmers keep abreast of news and the latest global developments. In addition, the sansars mail regular bulletins on farm-related news to subscribers. The training halls at the TKS are used for workshops and the screening of films related to agriculture. (Source: Link: www.tatatkk.com, Subject: Precision agriculture, information technology, extension delivery)

VASAT Project

Virtual Academy for the Semi-Arid Tropics (VASAT) is a coalition for Information, communication and capacity building, operating in South Asia (SA) and West and Central Africa (WCA) in partnership with the Desert Margins Program (DMP). VASAT links and mobilizes stakeholders for drought mitigation in the semi-arid tropics (SAT). It is an innovative and cost effective medium to educate and support a critical mass of rural women and men spread across vast geographical areas by informing them about drought and desertification. It is a response to the need of the United Nations Convention to Combat Desertification to implement a communication strategy for combating drought and desertification. VASAT disseminates knowledge on agriculture best practices from the rain fed areas of India and others. They do this through the innovative interface of ICT and distance learning, with a particular focus on the use of community radio. Initial work in this site included setting up a basic connectivity and computing infrastructure and extensive training to federation nominees (all women) in contemporary information management methods. The quality of information services offered by this federation is today recognized by the district administration, who has granted them the status of a rural e-seva or e-governance center, one of the first such rural centers in the State of AP. The site also serves as the test bed for evaluating a number of agricultural and livestock information products.

VASAT is involved in developing Micro-level drought vulnerability prediction maps and local long range forecast for rainfall of Adakkal Mandal from last three years. It is a partnership coalition that aims to mobilize communities **and** rural service providers in the dry tropics by sharing information, knowledge and skills related to climate literacy, drought preparedness, best practices in dry land agriculture, and other relevant issues. This is achieved through the innovative interface of ICT and distance learning. (Source: Link: <http://www.icrisat.org/vasat/index.Htm>, Subject: Drought mitigation, communication strategy, distance learning, <http://www.e-agriculture.org>)

Solution Exchange

Solution Exchange, an initiative of the United Nations Agencies in India, is harnessing the power of Communities of Practice to help attain national development goals and the Millennium Development Goals (MDGs), leveraging the knowledge, experience and energies of development Practitioners towards the common objective of problem-solving. While "expert" knowledge is often well documented, valuable tacit knowledge gained through practitioner experience is typically lost or ignored. Furthermore, practitioners cannot always access knowledge they need, such as whether a particular idea was tried before or where to turn when facing a bottleneck. To harness this knowledge pool and help development practitioners avoid reinventing the wheel, the United Nations offices in India created Solution Exchange: a free, impartial space where professionals are welcome to share their knowledge and experience. Members represent a wide range of perspectives from government, NGOs, donors, private sector and academia. They are organized into communities of practice built around the framework of the Millennium Development goals. Through moderated e-mail groups, members interact on an ongoing basis, building familiarity and trust, gaining in knowledge that helps them contribute more effectively-individually and collectively to the nation's development challenge.

Launched in 2005, Solution Exchange (SE) is a unique initiative by the United Nations in India that provides an impartial platform for exchange of knowledge and ideas among 33,000 (and growing!) development practitioners across 13 thematic areas (Communities of Practice COPs).(<http://www.undp.org>).

To put it briefly, Solution Exchange is a United Nations common initiative that leverages the power and potential of managed Communities of Practice (CoPs) to effectively address development priorities and the MDGs; tapping into the knowledge, experience and energies of members for collective problem-solving. Since first being introduced in India in 2005, Solution Exchange's proven methodology has benefited over 25,000 professionals from government, United Nations, NGOs, research and academic institutions, donors and the private sector, addressing over 1,100 wide-ranging policy, programme and implementation concerns. Currently eighteen Solution Exchange Communities of Practice are active in India, Bhutan, Bangladesh, the Pacific, and Russia.

With Solution Exchange, development practitioners can attain better results for

- Informed decision making - knowledge at your fingertips
- Faster feedback on issues - speeding up plan-to-action
- Building local capacities while reducing costs - better value for money
- Enhanced development effectiveness

(Source: <http://www.solutionexchange-un.net.in/en/index.php> & MANAGE.2012.Information and Communication Technologies in Agricultural Information Management and Networking, Training module.)

Agricultural Information Networks

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Now it is imperative to have a look into the Agricultural Information Networks (AIS). A number of virtual information networks with the objective of linking agricultural institutions for facilitating better access to information resources have been initiated successfully. While some of these network agricultural institutions within a country, link to agricultural institutions around the globe. The conspicuous ones are profiled here.

Agriculture Network Information Center (AgNIC) www.agnic.org

The very important component requiring considerable attention is AgNIC. It is an Internet based network of public and private agricultural libraries and information centers, coordinated by the National Agriculture Library (NAL), USA. The network aims to provide global access to agricultural information. AgNIC Members represent 40 land-grant universities and other national and international partners including universities and research institutions, government agencies, and a non-profit organization. Through its website, the network provides access to a network of electronic sources on research and teaching in agriculture, food, renewable natural resources, forestry, and physical and social sciences. AgNIC is a distributed discipline-oriented source of agricultural information in electronic form on the Internet. The goals are to: identify major collections of agriculture-related information; provide mechanisms to facilitate access/ retrieval from these information resources; create mechanisms to encourage organizations to collaborate in creating/ using AgNIC. AgNIC partners select important information sources for inclusion in the system. Services include: Resource database with web sites, image collections, lists of publications, documents, databases, and other resources; Calendar of events which includes meetings, seminars, national and international symposia and conferences, conventions, and workshops in agricultural and related sciences; news items; specialized services-such as Plant Disease Announcements; discussions on emerging plant diseases

around the world; Expertise where specialists respond to individual questions (NAL, 2006). There are partnerships between libraries and United States Department of Agriculture (USDA) Cooperative Extension programs; between libraries and academic departments within colleges; between states and between technologists and librarians. Member participants take responsibility for small segments of agricultural information and develop Web sites and reference services in their specific subject areas. Nearly all participating AgNIC institutions have developed partnering relationships with a variety of internal and external institutions, groups, and agencies to develop content and tools for their respective web sites.

It can be observed that the Agriculture Network Information Center (AgNIC) alliance was formed in 1995 by a group of four land grant institutions - Cornell University, Iowa State University, University of Arizona, and University of Nebraska, Lincoln, and the U.S. Department of Agriculture's National Agricultural Library (NAL). In 1998, NAL assumed the role as "secretariat" to move the partnership forward. Members were committed to creating a voluntary "alliance" dedicated to providing Internet access to quality, authoritative agricultural information, and specialized reference services. In 2007, with 60 voluntary partners, this vision continues to sustain the Alliance, largely due to its collaborative nature. University libraries affiliated with land-grant colleges as well as other interested institutions, such as the International Rice Research Institute, the American Farmland Trust, the Agricultural Information and Documentation Service for America (SIDALC) and the University of Buenos Aires, School of Agriculture, Central Library, are working together with NAL to develop the AgNIC Alliance, its collections and services, and the technologies upon which it relies. Unlike most science and technology disciplines, agriculture has a mechanism for distilling and distributing research to those who need it. Historically, state and local extension staff research topics, synthesize, and prepare information for easy consumption, often on an "as needed" basis. Forming partnerships between libraries and subject specialists has been the cornerstone of AgNIC.

AgNIC is a distributed network, which provides access to agriculture-related information, subject area experts, and other resources. It was established due to joint effort of the National Agricultural Library, land-grant universities and other organizations committed to facilitating public access to agricultural and related information and went on public in Oct.1995.

Objectives

Looking into the true perspective, AgNIC focuses on providing access to quality agricultural information in electronic format available over the World Wide Web (WWW) via the Internet. One of the objectives of AgNIC is that member participants take responsibility for small vertical segments of agricultural information (including basic, applied, and developmental research, extension, and teaching activities in the food, agricultural, renewable natural resources, forestry, and physical and social sciences) and develop WWW home pages in that specific area of responsibility. The collective AgNIC WWW resource will benefit all members in ways that they cannot achieve

on their own, thus justifying the local costs of participation (Source: AgNIC Home page "agnic.org". <http://www.agnic.org/>)

International Information System for Agricultural Sciences and Technology (AGRIS)
<http://www.fao.org/agris>

The Food and Agriculture Organization (FAO) of the United Nations initiated Agricultural information networking through AGRIS. Established in 1974 AGRIS facilitates information exchange and bring together world literature dealing with all aspects of agriculture and related subjects. AGRIS is a co operative system in which 240 national, international and intergovernmental centers in participating countries input references to the literature produced within their countries draw on the information provided by the other participants. The new vision of AGRIS in response to the needs include; decentralized approach with greater emphasis on national partnerships, improved linkages between the AGRIS network and other FAO initiatives; focus on management of documents in agricultural science and technology in full text; information about activities, organizations, and people in agricultural science and technology; etc

AGRIS (International System for Agricultural Science and Technology) is a global public domain database with more than 4 million structured bibliographical records on agricultural science and technology. The database is maintained by FAO, and its content is provided by more than 150 participating institutions from 65 countries. The AGRIS Search system, allows scientists, researchers and students to perform sophisticated searches using keywords from the AGROVOC thesaurus, specific journal titles or names of countries, institutions, and authors. (<http://en.wikipedia.org>)

AGRIS covers the wide range of subjects related to agriculture, including forestry, animal husbandry, aquatic sciences and fisheries, human nutrition, and extension. Its content includes unique grey literature such as unpublished scientific and technical reports, theses, conference papers, government publications, and more. A growing number (around 20%) of bibliographical records have a corresponding full text document on the web which can easily be retrieved by Google. Access to the AGRIS Repository is provided through the AGRIS Search Engine. As such, it:

- enables retrieval of bibliographic records contained in the AGRIS Repository,
- allows users to perform either full-text or fielded, parametric and assisted queries.

(Source: "agris.fao.org". agris.fao.org.)

Agrigate (www.agrigate.edu.au)

Coordinated by the national level libraries of Australia is a project of the Universities of Melbourne, Adelaide and Queensland and the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. This is subject information gateway for resources, both online and offline, in agricultural research. The purpose is to support the identification and dissemination of quality research materials selected by an editorial review process consisting of members of the agricultural research community. The resources selected have been reviewed by subject specialist librarians. The majority of resources identified in the data base are available online.

Consultative Group on International Agricultural Research (CGIAR)

CGIAR is a research network of fifteen international agricultural research centers. The 15 centers supported by the CGIAR are independent institutions, each with its own charter, international board of trustees, Director General and staff. The institutions are Africa Rice Center(WARDA), Biodiversity international, Centro Internacional de Agricultural Tropical(CIAT), Center for International Forestry Research(CIFOR), International Maize and Wheat improvement Centre(CIMMYT), International Potato Centre(CIP), International Center for Agricultural Research in the Dry Areas (ICARDA), International Crop Research Institute for Semi Arid Tropics(ICRISAT), International Food Policy Research Institute (IFPRI), International Institute of Tropical Agriculture (IITA), International Livestock Research Institute(IRRI), International Water Management Institute(IWMI), World Agro-Forestry Centre(ICRAF) and World Fish Center(WFC). Thirteen of the 15 CGIAR centre are located in developing countries and the knowledge gathered is shared and disseminated across the world. The CGIAR website gives access to a Virtual Information Centre and Library. One can tap into agricultural information database, including online libraries of the CGIAR Centre and the core collection Database. The CG Library gives access to database and e-journals and facility to go directly to the full text of publications. One can search CGIAR libraries/other agricultural libraries/by specific topics. The Virtual Information Center provides information on various topics mentioning the source against each topic. Each institutional library is the source for/and responsible for providing information on specific subject areas viz: Agriculture in the Dry Areas- ICARDA library; Agriculture in Semi Arid Tropics: ICRISAT library; Agro-forestry: ICRAF library; Aquaculture and Fisheries: WFC library; Food Policy: IFPRI library, Agricultural Biodiversity: IPGRI library; Water Management-IWMI library; Wheat: CIMMYT library, etc.

In brief, the CGIAR (formerly the Consultative Group on International Agricultural Research) is an international organisation which funds and co-ordinates research into agricultural crop breeding with the goal of "reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources". It does this through a network of 15 research centers known as the CGIAR Consortium of International Agricultural Research Centers. These research centers are spread around the globe, with most centers located in the Global South, at Vavilov Centers of agricultural crop genetic diversity. CGIAR research centers are

generally run in partnership with other organizations, including national and regional agricultural research institutes, civil society organizations, academia, and the private sector. (Source: [cgiar.org](http://www.cgiar.org/who-we-are/), <http://www.cgiar.org/who-we-are/>, Rice, Africa. "CGIAR". Consortium.cgiar.org. Kloppenburg, Jr., Jack Ralph (2004) *First the Seed: The Political Economy of Plant Biotechnology, 1492-2000*, Second Edition, Madison: University of Wisconsin Press)

Achievements

Over a period of 40 years, the CGIAR system, with the support of Canada and other donors, has:

- Improved wheat, maize and rice crops in developing countries, resulting in benefits of more than US\$10 billion annually
- Triggered the production of additional food in developing countries—\$9 worth of additional food for every \$1 invested in CGIAR research
- Increased average per capita food consumption
- Prevented malnutrition in at least 13 million children, predominantly in South Asia
- Increased food production in developing countries
- Lowered world grain prices
- Supported crop genetic improvement
- Produced average yield gains of 20 percent in drought-tolerant maize grown on 1 million hectare of land in Africa

Information Network on Post-harvest Operations (INPhO) www.fao.org/inpho/

INPhO is an FAO databank project of the Post-harvest management Group. It is an international collaborative effort by the FAO, GTZ and, CIRAD which aims to support the collection and dissemination of information on proven technologies and products in post harvest systems. Components of the network include a comprehensive collection of information on post harvest issues, communication/interactive services; links with other databases. The website includes full text documents of training and technical publications, country profiles, crop profiles (main focus is on cereals and grains, fruits and vegetables, oil seeds, roots and tubers). Recipients of this information include people working in the agricultural production and marketing sector viz., producers, researchers, policy makers, private investors and donors (FAO, 2006). The Information Network on Post-Harvest Operations (INPhO) was designed by FAO with the support and collaboration of GTZ and CIRAD. The main objective is to increase the development of activities of the global post-harvest sector for tropical agricultural products for a better access to technical data and an exchange of information among the different post harvest actors. Food security has two legs: production and post-production, and only a well managed post-production system allows the consumer to have access to the food produced. In this context and to assist in preventing the loss of millions of tons of cereals, roots, tubers, fruits and vegetables in developing countries, caused by inadequate handling and storage, pest damage, transport and marketing problems, INPhO started to operate. In the site you can find fact sheets on products, equipment, traditional storage, a photo gallery, and a document and video library.

(Source: <https://www.agriskmanagementforum.org>)

Electronic Publishing in Agriculture

Electronic Publishing (e-Publishing) is quickly becoming an important part of publishing mainstream. Recent innovations in this area have made it possible to publish on the information super highway. E-document can be accessed at the computer. It makes much easier for readers to search the information. It is very quick and easy for a reader to browse the table of the contents of previous issues, to jump directly to a particular section of a document or even particular section of an article.

Advantages of e-Publishing

E-Publishing (EP) difference lies in the new levels of value it provides through features not possible in traditional media. EP products may differ to an even greater degree than print products. Nevertheless, there are some common features, to distinguish EP from print publishing in terms of value to end users. EP products create additional value for the user with regard to following three dimensions: content availability, content transparency and interactivity and content format. Content availability means that EP products can be delivered and accessed with more independence of time and place than can be traditional print products and that their delivery is less limited with regard to quantity. Content availability includes: time of delivery available any time; location of delivery- consumption anywhere; amount of information- end of traditional boundaries imposed by paper volume and price. Content transparency and interactivity refers to new tools and opportunities concerning information navigation. The main features are Interactivity- contextual hyperlinks open new dimensions of information retrieval and lead to new types of information behavior: browsing, etc. the possibility to integrate content and services; and search tools across one or thousands of documents- interactive information processing.

Electronic Publishing in Agriculture in India

The Directorate of Information and Publications of Agriculture, (DIPA), New Delhi, is the official publication wing of the ICAR through which the research and other activities are revealed to the world. DIPA brings out a variety of Publications in English and Hindi languages for the use of scientists, Researchers, students, policy planners, extension personnel, farmers and the General public. The e-publications of DIPA include- "Handbook of Horticulture", ICAR Research Projects Information- Research Project Files (RPF) Database, ICAR Vision 2020 Document etc. Some other important Institutions bringing out e-publications' in Agriculture in India include, National Institute of Agricultural Extension Management, MANAGE, Hyderabad (www.manage.gov.in), Indian Agricultural Research Institute, New Delhi (www.iaripusa.org), Indian Farmers Fertilizer Cooperative Limited (IFFCO), (www.iffco.nic.in), Krishak Bharati Co-operative Limited (KRIBHCO), (www.kribhco.net), National Bank for Agricultural and Rural Development (NABARD) (www.nabard.org), National Agricultural Co-operative Marketing Federation of India Ltd.

(NAFED) (www.nafed-india.com), Indian Agricultural Statistics Research Institute (IASRI), New Delhi (www.iasri.res.in) and State Agriculture Universities of Tamilnadu, Uttarakhand, Punjab, Haryana and Andhra Pradesh. Two major open universities namely Indira Gandhi National Open University (IGNOU), Delhi and Yeshwantrao Chavan Maharashtra Open University (YCMOU), Nashik and National Institute of Agricultural Extension Management (MANAGE), Hyderabad have taken open and distance learning in Agriculture on a national scale, and all these institutions are in the process of bringing out a number of e-publications in Agriculture.

Electronic publishing (also referred to as ePublishing or digital publishing) includes the digital publication of e-books, EPUBs, Digital Magazines (also sometimes known as electronic articles), and the development of digital libraries and catalogues. Electronic publishing has become common in scientific publishing where it has been argued that peer-reviewed scientific journals are in the process of being replaced by electronic publishing. It is also becoming common to distribute books, magazines, and newspapers to consumers through tablet reading devices, a market that is growing by millions each year, generated by online vendors such as Apple's iTunes bookstore, Amazon's bookstore for Kindle, and books in the Google Play Bookstore. Market research suggests that half of all magazine and newspaper circulation will be via digital delivery by the end of 2015 and that half of all reading in the United States will be done without paper by 2015. Although distribution via the Internet (also known as online publishing or web publishing when in the form of a website) is nowadays strongly associated with electronic publishing, there are many non network electronic publications such as Encyclopedias on CD and DVD, as well as technical and reference publications relied on by mobile users and others without reliable and high speed access to a network. Electronic publishing is also being used in the field of test-preparation in developed as well as in developing economies for student education (thus partly replacing conventional books) - for it enables content and analytics combined- for the benefit of students. The use of electronic publishing for textbooks may become more prevalent with eBooks from Apple Inc. and Apple's negotiation with the three largest textbook suppliers in the U.S.

Electronic publishing is increasingly popular in works of fiction as well as with scientific articles. Electronic publishers are able to provide quick gratification for late-night readers, books that customers might not be able to find in standard book retailers (erotica is especially popular in eBook format and books by new authors that would be unlikely to be profitable for traditional publishers. While the term "electronic publishing" is primarily used today to refer to the current offerings of online and web-based publishers, the term has a history of being used to describe the development of new forms of production, distribution, and user interaction in regard to computer-based production of text and other interactive media.

Electronic versions of traditional media:

- CD-ROM
- E-book

- Electronic journal
- Online magazine
- Online newspaper
- PDF

New media:

- Blog
- Collaborative software
- Digital publication app
- File sharing
- Mobile apps
- Podcast (<http://en.wikipedia.org/>)

Electronic mail (E-mail), compact disc read only memory (CD-ROM), and electronic journals (E-journals; online journals) are common everyday terms that only originated in the 1980s (WWWebster Dictionary, 2000; www.m-w.com/dictionary.htm). Yet, these words are increasingly found in everyday conversations of people of all ages, professions, countries, and businesses. Electronic publishing has revolutionized the way we think, talk and act. In less than 20 years, changes in communication and information management (the essence of electronic publishing) have become so profound that the era we now live in is called Information Age. An Age that is not completely understood by many of us living in it, but will be scrutinized by historians and studied by school children as the Industrial Revolution and Space Age have been examined by current generations. Of importance to nursing, other healthcare providers and consumers experiencing this latest era of change is how electronic publishing is altering and reforming how we communicate and control information in our lives.

The purposes of this article are to provide an overview of electronic publishing, to describe how information increasingly is being exchanged within the scientific community, and to discuss the scholarly qualifications of electronic venues. First, we will discuss what is meant by electronic publishing and second, give examples of usage and types of electronic publishing. Third we will examine how electronic publishing, particularly e-journals are used in nursing and health care. Fourth, we will discuss the advantages and disadvantages of electronic journals and fifth, discuss the advantages and disadvantages of print journals. We will end with a look into the 21st century and project how electronic journals maybe used by nurses in the future.

Use of and Types of Electronic Publishing

The use of computers has exploded. Currently there are 43 million connected computers across the world (Matrix Information and Directory Services, Inc, 1999www.ngi.org/trends/TrendsPR9902.txt, www.ngi.org/trends/trendsregional.html). Worldwide there are projected to be over 200 million users online over the age of 16 (NUA survey, 1999, (www.nua.net/surveys/how_many_online/world.html)). The use of electronic

medium enables a large segment of the peoples of the world to seek out information and exchange ideas for personal, business, and/or educational use. In the United States, for example, fifty percent of all students had access to the use of computers for studying math (ETS's Policy Information Center, 1999.www.ets.org/research/pic/ccsum.html). Using the framework of communication and managing information this section will provide an overview of the ways computers are used a) to send messages and network and b) provide for information management.

Messaging and networking

Messaging and networking are two means of using electronic publication for communication. Messaging through e-mail is one of the most widely established ways to communicate and allows one or more persons to correspond in writing. Networking allows messages to be sent and discussions to occur among a few people or in some cases among thousands of people. As both messaging and networking use an e-mail type application, e-mail will be briefly reviewed first. For the novice user seeking more "how-to" information on e-mail. (Source: www.nursingworld.org/ www.webfoot.com/advice/email.context.html, www.pbs.org/uti/guide/email.html, www.pb.org/emoticon.html.)

E-mail can be likened to letter or note writing. However, instead of mailing a written copy through a carrier such as a postal service or leaving a message on someone's desk, a note/letter is electronically published through computers. While most e-mail is simply a written message, a file or files can be sent along with the e-mail. These attachments can contain pictures, video, audio, or long text or database files like protocols, articles or research data. (Electronic Publishing: The Movement From Print To Digital Publication)

Open Access to Information Retrieval

Open Access (OA) is free, immediate, permanent online access to the full text of research articles any. There are two roads to open Access:

(1) the "golden road" of OA journal-publishing , where journals provide OA to their articles (either by charging the author-institution for Refereeing/publishing outgoing articles instead of charging the user-institution for accessing incoming articles, or by simply making their online edition free for all);

(2) The "green road" of OA self-archiving, where authors provide OA to their own published articles, by making their own e-prints free for all.

The two roads to OA should not be confused or conflated; they are Complementary: An Open Access Publication is one that meets the following two conditions:

1. The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use.

2. A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by

an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (for the biomedical sciences, PubMed Central is such a repository).

According to Directory of open Access Journals (DOAJ, 2008), open access journals are defined as journals that use a funding model that does not charge readers or their institutions for access. Acceptance of OA archiving does not mean abandoning peer review or ceasing to publish journals. It merely means the parallel archiving of all research papers in interoperable institutional archives searchable by all on the Internet, a process increasingly accepted by major journals. This process is almost cost-free since it can be carried out by individual researchers themselves, or by their institutions, paper by paper. Software for establishing e-print archives is available free to all. Alternatively, OA can be achieved by publication in the increasing number of OA journals. In these, the cost of document management is met by the contributors or their organizations, rather than the readers, so that accessing the content remains free to all. A number of journals published in developing countries are converting to OA, since the value to their countries of international visibility is recognized as being of far greater importance than the small amount of income the journals generate. For example, the Indian Institute of Science has established an "eprints" archive and there is now significant OA activity in the sub-continent (New institutional archives being established, workshops on OA being organized). Similarly the Central Marine Fisheries Research Institute (CMFRI) of ICAR also established eprints of entire publications as institutional repository consisting of more than 10000 research papers uploaded along with other publications like journal and periodicals of the institute.

The recent agreement to provide free or low cost journals to the poorest countries by publishers that make few sales in these areas is a welcome development (eg WHO HINARI and INASP PERI projects), and can alleviate information poverty for some countries in the immediate term. However, these efforts are unlikely to be sustainable and exclude many poor countries where collaborating publishers may lose sales, such as India. In the longer term the worldwide acceptance of OA is the only mechanism, immediately available and at almost no cost, that can provide equality of access as well as professional inclusion for developing country. Scientific information is both a researcher's greatest output and technological innovation's most important resource. The rising cost of journal subscription is a major force behind the emergence of the open access (OA) movement. The emergence of digitization and Internet has increased the possibility of making information available to anyone, anywhere, anytime, and in any format. The major benefits of OA include: Researchers and students gain increased access to knowledge, publications receive greater visibility and readership, the potential impact of research is heightened, increased access to and sharing of knowledge leads to opportunities for equitable economic and social development, intercultural dialogue, and has the potential to spark innovation. OA improves the speed, efficiency, and efficacy of research as also OA enables computation upon the research literature.

With this backdrop, it is heartening to note that biomedical scientists are increasingly gaining access to medical literature for a variety of assignments like writing a research paper or a research proposal or even staying current with advances in biomedical field.

Thanks to OA, a number of sources are now available in the biomedical field apart from PubMed (<http://www.ncbi.nlm.nih.gov/pubmed>), which provides free access to the largest biomedical resource available and is updated daily. Specifically, PubMed listed 5,645 journals (as on January 1, 2013) indexed from various countries.(2) A total of 42 (0.74 %) journals are included from India (also as on January 1, 2013).(3) Encouragingly, the national initiative by the Indian Council of Medical Research (ICMR) funded project, 'National database of Indian medical journals' by the National Informatics Centre Services Inc. (NICSI), New Delhi, provides among others, a bibliographic database of about 100 prominent peer - reviewed Indian biomedical journals indexed from 1985 onwards through indMED (<http://indmed.nic.in/>, accessed on January 1, 2013) as also full text of 63 Indian biomedical journals (medIND).(4) It supplements international indexing services like PubMed. It simply means one gets 45,928 records using 'contraception' as the key word in PubMed, while another exclusive 170 Indian records using 'contraception' as the key word in indMED.

1. Swan A. Policy guidelines for the development and promotion of open access. Paris: United Nations Educational, Scientific and Cultural Organization; 2012.)

2. Currently Indexed Journals in PubMed. [Last accessed on 2013 Jan1]. Available from: <http://www.ncbi.nlm.nih.gov/nlmcatalog?term=currentlyindexed%5Ball%5D> .

3. Currently indexed journals in PubMed from India. [Last accessed on 2013 Jan 1]. (Source: <http://www.ncbi.nlm.nih.gov/nlmcatalog?term=currentlyindexed%5Ball%5D%2B%20Indi>)

Open Access in India

Open Access is gaining momentum in India, Some' major Indian institutions, which have joined the Open Access movement include:

1. Indian Institute of Science, Bangalore
2. Indian Academy of Sciences, Bangalore
3. Indian Institute of Astrophysics, Bangalore
4. Raman Research Institute, Bangalore
5. Indian Statistical Institute, Bangalore
6. National Chemical Laboratory, Pune
7. University of Hyderabad, Hyderabad
8. Indian Institute of Technology, New Delhi
9. Indian Institute of Technology, Kharagpur
10. Indian Institute of Management, Kozhikode
11. Indian Statistical Institute, Kolkata
12. Indira Gandhi Institute for Development Research, Mumbai
13. G.B. Pant University of Agriculture and Technology, Pantnagar, Uttaranchal
14. National Institute of Oceanography, Goa
15. National Institute of Technology, Rourkela
16. Sri Venkateswara University, Tirupati

Institutional Repositories

Institutional Repositories (IRs) are the digital information warehouses of modern academic institutions. According to Clifford Lynch (2003), the IRs are "a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members". The key features of a professionally managed IR are: Rich digital Content, up to date full-length Institutional Research papers, full participation of all Research Scientists of the organization, and fully supported by top administration. The benefits of Institutional Repositories include- higher visibility in academic circles, better reach through WWW, efficiency through Centralization of Digital content, wider access and visibility, improved impact. and citation of their work, Opportunity to share unpublished ideas and know-how, motivation for junior researchers through immediate presence on IR. The IRs also promotes information documentation habit in young researchers and development functionaries.

An institutional repository is an online locus for collecting, preserving, and disseminating in digital form, the intellectual output of an institution, particularly a research institution. For a university, this would include materials such as research journal articles, before (preprints) and after (post prints) undergoing peer review, and digital versions of theses and dissertations. It might also include other digital assets generated by academics, such as administrative documents, course notes, or learning objects.

The four main objectives for having an institutional repository are:

- to provide open access to institutional research output by self-archiving it;
- to create global visibility for an institution's scholarly research;
- to collect content in a single location;
- to store and preserve other institutional digital assets, including unpublished or otherwise easily lost ("grey") literature such as theses or technical reports.

Advantages:

- Opening up outputs of the institution to a worldwide audience;
- Maximizing the visibility and impact of these outputs as a result;
- Showcasing the institution to interested constituencies – prospective staff, prospective students and other stakeholders;
- Collecting and curating digital output;
- Managing and measuring research and teaching activities;
- Providing a workspace for work-in-progress, and for collaborative or large-scale projects;
- Enabling and encouraging interdisciplinary approaches to research;

- Facilitating the development and sharing of digital teaching materials and aids,
- Supporting student endeavours, providing access to theses and dissertations and a location for the development of e-portfolios.(en.wikipedia.org)

Institutional Repositories in India

In India, there are 16 functional institutional repositories, developed by research and academic institutions of national and international importance, such as Indian Institute of Science, Indian Institute of Management etc. Apart from institutional repositories, subject specific repositories also exist in India. These store and provide access to subject specific collections of documents. These repositories accept scholarly publications from any professional or researcher who belongs to the respective subject. *Librarian's Digital Library* (LDL) of the Documentation Research and Training Centre (DRTC), Bangalore is an example of a subject-specific repository for library and information professionals. Another subject-specific repository established in India is *OpenMed@NIC*, maintained by the National Informatics Centre, New Delhi. OpenMed@NIC stores and provides access to biomedical literature. Another kind of digital repository existing in India stores and provides access to document type specific collections. Vidyanidhi of the University of Mysore is an example of document type specific collection that stores and provides access to theses and dissertations (Cross institutional ETD repository). Vidyanidhi accepts any thesis or dissertation that has been accepted in any of the Indian universities or institutions (Fernandez, 2006).

It has found that all institutions had done planning and pilot testing before implementation of an IR. "Attending institutional repository software implementation training and workshops" and "Demonstrating an operational institutional repository to my institution's decision-makers" were the most exercised exploratory activities. All respondents agreed on the benefit that an IR provides "Better service to contributors and institution's learning community". "Contributor's lack of knowledge" was the most important inhibitor that impedes the web administrator's ability to set up a successful institutional repository. (Source: <http://www.emeraldinsight.com>)

Importance of Institutional Repositories

IRs in universities generally include pre-prints of journal articles, seminar papers, technical reports, research data, theses, dissertations, work in progress, important print and image collections, teaching and learning materials, and other materials, documenting the history of the institution. For several years, universities and R&D institutions have been primarily responsible for creation of new knowledge by investigating activities. These are in the form of theses, dissertations, project reports, courseware, pre-prints, etc. These documents carries huge amount of valuable data and material which is probably not available in any published resource. Unfortunately these are inaccessible in the absence of appropriate mechanisms such as bibliographic control access. Even those resources that eventually appear in print and are published may still be inaccessible to a vast majority of institutions due to the high cost of subscription to the source material in which they are

published. IRs are widely seen as one way of enhancing wider access to research carried out using public funds while at the same time improve visibility of research especially for developing countries. Thus, for universities/institutions, IRs are marketing tools, communicating available expertise and quality by showcasing output of faculty and research scholars, public service projects, and other activities and collection. IRs also complements existing metrics for gauging institutional productivity and prestige. While the increased visibility reflects a high quality of scholarship, this demonstration that value can also translate into tangible benefits, including attracting funding from public and private sources increasing the institution's status and reputation. With the availability of advanced information and communication technologies (ICTs) and by building up necessary infrastructure in India, particularly in academic institutes, this will become an active contributor to global open access literature. IRs in universities generally include pre-prints of journal articles, seminar papers, technical reports, research data, theses, dissertations, work in progress, important print and image collections, teaching and learning materials, and materials documenting the history of the institution. (Best practices in institutional repositories in Indian universities and research institute, Madaiah Krishnamurthy DRTC, Indian statistical institute, Bangalore560059,Talawar.V.G,University of Mysore, Jagirdar NAAC Bangalore)

Institutional Repositories in India are less than five years old; many are in the testing phase and none have more than a few thousand papers. The Indian Institute of Science was the first in the country to set up an interoperable institutional repository (ePrints@IISc) in 2002 (eprints.iisc.ernet.in). The archive now has more than 3,000 documents, with over 90% having full text. The Institute has a separate Archives Unit and well documented submission guidelines. Other Institutional repositories are new and not rich in content. Many are in the testing phase, and none have more than 500 papers. Eprints@CMFRI is the Open Access Institutional Repository of Central Marine Fisheries Research Institute. Research outputs of CMFRI - journal papers, conference papers, reports, theses, patents etc. - are uploaded/self-archived by CMFRI scientists who do research on fisheries and related areas. Interested users can freely download and use documents as most of them are directly accessible and full-text downloadable.

OA and IR movement has certainly helped the Indian journals to reach an international audience, as could be seen by the number and distribution of article downloads. The Journal of Postgraduate Medicine, a quarterly journal with a print circulation of less than 1,000 attracts close to 1,00,000 visitors with more than 110,000 article downloads per month. The increased accessibility and visibility has also increased the citations received by this journal (Sahu, Gogtay and Bavdekar, 2005). Professor Subbiah Arunachalam of the M. S. Swaminathan Research Foundation, Chennai, is the greatest OA advocate in the country. He organized a workshop on 'Open Access and Institutional Repositories under the aegis of the MSSRF, Chennai in May 2004. A special session on OA was held at the 93rd Indian Science Congress held at Hyderabad in January 2006, which came up with some far reaching recommendations for the 'Optimal National Open Access Policy'. According to their recommendations, "The Government of India expects authors of research papers resulting from publicly funded research to maximize the opportunities to make their results available for free. To this end, the Government requires electronic copies

of any research paper that has been accepted for publication in a peer-reviewed journal, and is supported in whole or in part by Government funding, to be deposited into an Institutional OA repository immediately on acceptance for publication."

CMFRI Open Access Institutional Digital Repository places CMFRI as the first ICAR institute to reach this stage and CMFRI also ranks first at national level and fifth at the global level among the open access repositories on marine sciences. Among all IR (including all disciplines), CMFRI ranks in 499th place in ranking the web of world repositories and 112th place in Google scholar. (Source: <http://repositories.webometrics.info/roprep.asp>, MANAGE. 2012. Information and Communication Technologies in Agricultural Information Management and Networking, Training module.)

Role of ICT in Knowledge Management

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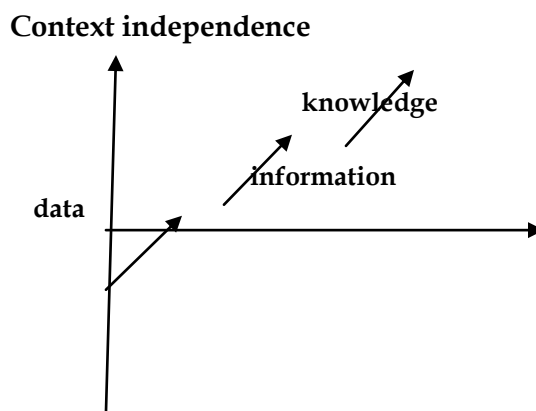
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It is inevitable to know about the significant role of ICT in Knowledge Management. Knowledge management comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insight and experiences comprising knowledge, either embodied in individuals or embedded in organizational process or practice. The concerted efforts on Knowledge Management typically focus on organizational objectives such as improved performance, competitive advantage, innovation, the sharing of lessons learned, integration and continuous improvement of the organization. KM efforts overlap with organizational learning and may be distinguished from that by a greater focus on the management of knowledge as a strategic asset and a focus on encouraging the sharing of knowledge. KM efforts can help individuals and groups to share valuable organizational insights, to reduce redundant work, to avoid reinventing the wheel per se, to reduce training time for new employees, to retain intellectual capital as employees' turnover in an organization, and to adapt to changing environments and markets.

Actually different frameworks for distinguishing between knowledge exist. One proposed framework for categorizing the dimensions of knowledge distinguishes between tacit knowledge and explicit knowledge. Tacit knowledge represents internalized knowledge that an individual may not be consciously aware of, such as how he or she accomplishes particular tasks. At the opposite end of the spectrum, explicit knowledge represents knowledge that the individual holds consciously in mental focus, in a form that can easily be communicated to others. Early research suggested that a successful KM effort needs to convert internalized tacit knowledge into explicit knowledge in order to share it, but the same effort must also permit individuals to internalize and make personally meaningful any codified. Knowledge retrieves from the KM effort. Subsequent research into KM suggested that a distinction between tacit knowledge and explicit knowledge represented an oversimplification and that the notion of explicit knowledge is self-

contradictory. Specifically, for knowledge to be made explicit, it must be translated into information (i.e., symbols outside of our heads). Later on, Ikujiro Nonaka proposed a model (SECI for Socialization, Externalization, Combination, Initialization) which considers a spiraling knowledge process interaction between explicit knowledge and tacit knowledge. In this model knowledge follows a cycle in which implicit knowledge is 'extracted' to become explicit knowledge and explicit knowledge is re-internalized into implicit knowledge. More recently, together with George von Krogh, Nonaka returned to his earlier work in an attempt to move the debate about knowledge conversion forward.

Similarly, a second proposed framework for categorizing the dimensions of knowledge distinguishes between embedded knowledge of a system outside of a human individual (e.g. an information system may have knowledge embedded into its design) and embodied knowledge representing a learned capabilities of a human body's nervous and endocrine systems. A third proposed framework for categorizing the dimensions of knowledge distinguishes between the exploratory creation of 'new knowledge' (i.e. innovation) vs. the transfer or exploitation of 'established knowledge' within a group, organization, or community. Collaborative environments such as communities of practice or the use of social computing tools can be used for both knowledge creation and transfer.



It is to be noted that, before attempting to address the question of knowledge management, it is probably appropriate to develop some perspective regarding this stuff called knowledge, which there seems to be such a desire to manage, really is. Consider this observation made by Neil Fleming as a basis for thought relating to the following.

- A collection of data is not information.
- A collection of information is not knowledge.
- A collection of knowledge is not wisdom.
- A collection of wisdom is not truth..

We have to make out the idea that information, knowledge and wisdom are more than simply collections. Rather, the whole represents more than the sum of its parts and has a synergy of its own. We begin with data, which is just a meaningless point in space and time, without reference to either space or time. It is like an event out of context a letter out of context, a word out of context. The key concept here is "out of context." And, since it is out of context, it is without a meaningful "relation to anything else". When we encounter a piece

of data, if it gets our attention at all, our first action is usually to attempt to find a way to attribute meaning to it. We do this by associating it with other things. If we see the number 6, we can immediately associate it with cardinal numbers and relate it to being greater than 5 and less than 7, whether this was implied by this particular instance or not. If we see a single word, such as "time" there is a tendency to immediately form associations with, previous contexts within which we have found "time" to be meaningful. This might be "being on time," "a stitch in time saves 'nine," "time never stops," etc. The implication here is that when there is no context, there is little or no meaning. So, we create context but more often than not, that context is somewhat akin to conjecture, yet it fabricates meaning.

Still it is to be remembered that, as a collection of data is not information, as Neil indicated, it implies that a collection of data for which there is no relation between the pieces of data is not information. The pieces of data may represent information, yet whether or not it is information which depends on the understanding of the one perceiving the data. We would also tend to say that it depends on the knowledge of the interpreter, but we are, probably getting ahead of ourselves, since we haven't defined knowledge. What we will say at this point is that the extent of our understanding of the collection of data is dependent on the associations we are able to discern within the collection. And, the associations I am able to discern are dependent on all the associations we have ever been able to realize in the past. Information is quite simply an understanding of the relationships between pieces of data, or between pieces of data and other information.

As we understood, while information entails an understanding of the relations between data, it generally does not provide a foundation for why the data is what it is, nor an indication as to how the data is likely to change over time. Information has a tendency to be relatively static in time and linear in nature. Information is a relationship between data and quite simply, is what it is with great dependence on context for its meaning and with little implication for the future. Beyond relation there is pattern, where pattern is more than simply a relation of relations. Pattern embodies both a consistency and completeness of relationships which to an extent, creates its own context. Pattern also serves as an Archetype with both an implied repeatability and predictability.

Another point is that, when a pattern relation exists amidst the data and information, the pattern has the potential to represent knowledge. It only becomes knowledge, however, when one is able to realize and understand the patterns and their implications. The patterns representing knowledge have a tendency to be more self-contextualizing. That is, the Pattern tends, to a great extent, to create its own context rather than being context dependent to the same extent that information is. A pattern which represents knowledge also provides, when the pattern is understood, a high level of reliability or predictability as to how the pattern will evolve over time, for patterns are seldom static. Patterns which represent knowledge have completeness to them that information simply does not contain.

Similarly wisdom arises when one understands the foundational principles responsible for the patterns representing knowledge being what they are: And wisdom, even more so than knowledge, tends to create its own context. I have a preference for referring to these foundational principles as eternal truths, yet I find people have a tendency to be somewhat uncomfortable with this labeling. These foundational principles are universal and completely context independent. Of course, the last statement is sort of

redundant word game, for if the principle was context dependent then it couldn't be universally true. So, in summary the following associations can reasonably be made:

- Information relates to description, definition, or perspective (what, who when, where).
- Knowledge comprises strategy, practice, method, or approach (how).
- Wisdom embodies principle, insight, moral, or archetype (why).

The Value of Knowledge Management

To speak in an organizational context, data represents facts or values of result and relation between data and other relations have the capacity to represent information. Pattern of relations of data and information and other patterns have the capacity to represent knowledge. For the representation to be of any utility it must be understood. Yet what is the real value of information and knowledge, and what does it mean to manage it? In this example what needs to be managed to create value is the data that defines past result; the data and information associated with the organization, its market, its customer, and competition, and the patterns which relate all these items to enable a reliable level of predictability of the future. Knowledge Management is referred to be the capture, retention and reuse of the foundation understanding of how all these pieces fit together and how to convey them meaningfully to some other person.

Actually the value of Knowledge Management relates directly to the effectiveness with which the managed knowledge enables the members of the organization to deal with today's situations and effectively envision and create their future. Without on-demand access to managed knowledge, every situation is addressed based on what the individual or group brings to the situation with them. With on-demand access to managed knowledge, every situation is addressed with the sum total of everything anyone in the organization has ever learned about a situation of a similar nature. The question arising here is which approach would you receive would make a more effective organization?

In brief, Knowledge Management (KM) comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organizations as processes or practices. More recently, other fields have started contributing to KM research; these include information and media, computer science, public health, and public policy. Many large companies and non-profit organizations have resources dedicated to internal KM efforts, often as a part of their business strategy, information technology, or human resource management departments. Several consulting companies also exist that provide strategy and advice regarding KM to these organizations. Knowledge management efforts typically focus on organizational objectives such as improved performance, competitive advantage, innovation, the sharing of lessons learned, integration and continuous improvement of the organization. KM efforts overlap with organizational learning, and may be distinguished from that by a greater focus on the management of knowledge as a strategic asset and a focus on encouraging the sharing of knowledge. It is seen as an enabler of organizational learning and a more concrete mechanism than the previous abstract research.

What is it?

The knowledge element primarily focuses on information that can easily be recorded in documents, such as

- (1) Written technical documents and specifications
- (2) Engineering drawings and calculations
- (3) Specifications for design, fabrication, and installation of process equipment
- (4) Other written documents such as material safety data sheets (MSDSs).

Throughout this chapter, the term process knowledge will be used to refer to this collection of information. The knowledge element involves work activities associated with compiling, cataloging, and making available a specific set of data that is normally recorded in paper or electronic format. However, knowledge implies understanding, not simply compiling data. In that respect, the competency element complements the knowledge element in that it helps ensure that users can properly interpret and understand the information that is collected as part of this element. The knowledge and competency elements are closely linked in other ways as well. The competency element involves work activities that

- (1) Promote personal and organizational learning and
- (2) Help ensure that the organization retains critical information in its collective memory.

It is to be noted that, technology manuals and other written documents produced as part of the competency element are often stored and distributed via the knowledge element's management system. A key distinguishing feature of information developed as part of the knowledge element is that it generally has a high degree of structure, which applies to all processes. In addition, the primary objective of the knowledge element is to maintain accurate, complete, and understandable information that can be accessed on demand. Conversely, a technology manual compiled as part of the competency element often includes historical information; it is also less structured and is much more likely to include sections that are "under development" based on ongoing projects within the company's research and technology functions. Information collected and maintained by the knowledge element tends to answer questions starting with "What," for example, "What is the area and overall heat transfer coefficient for this heat exchanger?" whereas the competency element helps process knowledge users answer questions starting with "Why", such as, "Why is this heat exchanger ten times larger than it needs to be for routine service?" The knowledge element includes work activities to ensure that the information is

- (1) Kept current and accurate
- (2) Stored in a manner that facilitates retrieval

(3) Accessible to employees who need it to perform their process safety-related duties.

Why is it Important?

Risk understanding depends on accurate process knowledge. Thus, this element underpins the entire concept of risk-based process safety management; the RBPS methodology cannot be efficiently applied without an understanding of risk. Process knowledge also supports other RBPS elements. For example, the procedures, training, asset integrity, management of change, and incidents elements all draw on information that is collected and maintained as part of the knowledge element. (<http://www.aiche.org>)

Agriculture Knowledge Management: Role of Information and Communication Technology

It is a pertinent fact to observe that the emergence of Information and Communication Technologies (ICT) in the last decade has opened new avenues in knowledge management that could play important roles in meeting the prevailing challenges related to sharing, exchanging and disseminating knowledge and technologies. ICT allows capitalizing to a greater extent on the wealth of information and knowledge available for Agriculture Knowledge, Science and Technology (AKST). The ultimate objectives of AKST activities are to come up with results that can advance research more in certain areas, and engender technologies that AKST stakeholders can use to increase production, conserve the environment, etc.

Basically the first challenge is the poor mechanisms and infrastructure for sharing and exchanging agriculture knowledge generated from research at national and regional levels. Many research activities are repeated due to the lack of such mechanisms and infrastructure at the national level. Researchers can find research papers published in international journals and conferences more easily than finding research papers published nationally in local journals, conferences, theses and technical reports. The second challenge is the inefficient mechanisms and infrastructure for transferring technologies produced as the result of research to growers either directly or through intermediaries (extension sub-system). Knowledge and technologies fostering agricultural production and environment conservation are examples. Although many extension documents are produced by national agriculture research and extension systems to inform growers about the latest recommendations concerning different agricultural practices, these documents are not disseminated, updated or managed to respond to the needs of extension works, advisers and farmers. This is also true for technical reports, books and research papers related to production. Thus third challenge is keeping the indigenous knowledge as a heritage for new generations. It is available through experienced growers and specialists in different commodities. These inherited agricultural practices are rarely documented, but they embody a wealth of knowledge that researchers need to examine thoroughly. The fourth challenge is easily accessing and availing economic and social knowledge to different stakeholders at operational management and decision-making levels, so that those responsible will be able to make appropriate decisions regarding the profit making of certain technologies and their effect on resource poor farmers.

Statistics proves that almost 60–70% of more than a billion people depend on agriculture in India. One of the major constraints affecting agricultural productivity in the country is the problem of availability of timely and relevant agricultural information to the farmers. The existing ways of transfer of agri-technologies do not reach the majority of the small and marginal farmers across the country due to a large gap in the ratio of extension workers and farmers. From late twentieth century, there have been rapid advances in technology and improvisation in the ways the information is stored, processed and communicated. For faster transmission of improved farm technologies, information and communication technology (ICT) can play a significant role. The past decade has been characterized by changing patterns of rural market; hence, the role of ICT has been increased from providing the networks to setting up of the origin of modernised technical programmes in the rural vicinity. Various innovative ICT applications by both government and private initiatives have been developed for better communication and rapidly changing demand of the consumers in rural areas. This article reviews the ICT initiatives of Gyandoot, Warana Wired, e-Choupal, mKrishi project, etc., to comprehend their role in technology dissemination to the agricultural community and examining the changes in agricultural productivity due to their usage.

It is found that the ICT initiatives still require significant improvements in supporting infrastructure and capacity building amongst farmers to enable them to use the information they access effectively. As ICT access continues to increase among farming communities and information services continue to adapt and flourish, the scope exists for a much better rural productivity impact in the future (Source: <http://www.indianjournals.com>). Information and Communication Technology (ICT) was raised as a new feature in the Sudan agricultural sectors in the contemporary time. Usage of ICT to disseminate and share information in Sudanese rural areas is one of the important components of agricultural development in the country. The challenges are to make ICT available to rural people and to build efficient national agricultural information system to increase access to information at the national level, in addition to connect rural people to global information networks. The main objective of this study was to determine the use of Information and Communication Technologies (ICT) by extensionists in the Gezira State, Sudan. Field survey was used to collect data from 50 extensionists in the Gezira State. The collected data were statistically analyzed and interpreted using percentage and frequency distribution. The results showed that there are many constraints facing the use of ICT by the extensionists in the State include lack of personal computers, high cost of ICTs in general, lack of technical knowhow, lack of good infrastructure, lack of internet centres of Ministry of Agriculture in the villages, lack of internet cafes in the villages. It can be concluded that the majority of extensionists in the State still depend on the use of mobile phone and the traditional ICT (radio and TV) only in their contacts with farmers and the constraints which are facing them in their use of ICT in the State led to this unfavorable situation. Thus, more efforts should be exerted to the solution of ICT illiteracy in the country, agricultural extension organizations in the State should develop their programmes which are concerned with the use of new ICT by extensionists in their various agricultural extension work. The constraints which are facing the extensionists in their use of ICT in the State should be solved by all parties concerned with usage of ICTs. (Ahmed M. Abdul Rahman, Use of Information and Communication Technologies (ICTS) by Agricultural Extensionists in the

Gezira State, Sudan. Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.

In a broader theme, Knowledge sharing, exchanging and dissemination are elements which comprise knowledge management. The central purpose of knowledge is to transform information and intellectual assets into enduring value. (Metcalf, 2005). The basic idea is to straighten, improve and propel the organization by using the wealth of information and knowledge that the organization and its members collectively possess (Milton, 2003). It has been pointed out that a large part of knowledge is not explicit but tacit (Schreiber *et al.*, 1999). This is true for knowledge in agriculture where a lot of good practices are transferred without being well documented in books, papers or extension documents. To manage the knowledge properly, ICT is needed. In effect, there are many information technologies that can be used for knowledge management. The following paragraphs describe these technologies and emphasize their roles in agriculture knowledge management. Content management system in its wider sense including data bases and multimedia, is the core technology of information and knowledge management. This technology can be used in different applications:

In reality, building a national agriculture research information system (NARIS) needs to include research outcomes projects; institutions and researchers in every country, and a regional research information system that works as a portal for all the NARIS. Developing an information system of indigenous agricultural practices can enable researchers to examine this knowledge and decide on its usefulness for sustainable development. Such a system will also keep this knowledge for future generations before it disappears as a result of advanced technologies. Developing an information system recording matured technologies that on a trial basis have proven successful and success achieved economic growth will strengthen the interaction between Inventors and innovators. This will lead to an innovation-driven economic growth paradigm. Storing and retrieving image videotapes and audiotapes related to different agricultural activities. Geographic information systems (GIS) are needed to store databases about natural resources with a graphical user interface that enables users to access these data easily using geographical maps. Decision support system techniques are needed in many applications viz., Simulating and modeling methods can be used to build computer systems that can model and simulate the effect of different agricultural production policies on the economy and the environment to help top management make decision. Using expert systems technology improves crop management and tracks its effect on conserving nature. Expediting the expert systems development by generating agriculture specific tools to overcome the well known problem of knowledge is inevitable.

Mining growers' problems database which is part of the Virtual Extension and Research Communication Network (VERCON) to discover the best practices from the solutions provided by the human experts and find out whether there are any discrepancies in their recommendations. Modern ICT-Internet and Web technology is needed to make these systems available regionally and globally. Accessing the Internet will bring a wealth of information to all agriculture stakeholders in rural and urban areas and will help in

overcoming the digital divide. As most farmers have no hands on experience or access to digital networks, leaders of national agricultural research and extension systems should be encouraged to consider the ICT option, training farmers and extension workers including women in ICT will help them access a lot of useful information if each county tries to develop facilitate other rural services.

ICTs in Agricultural Knowledge Management

The toughest and mammoth task of driving the knowledge sharing process in agriculture necessitates extension to adapt to ICT mediated Knowledge Management (KM). Of late, organisations in agriculture realised the importance of managing the knowledge (implicit & explicit; internal & external) for effective targeting and dissemination. The new face of 'digital divide' is "digital information/knowledge divide". Knowledge management can play a pivotal role in enhancing agricultural productivity by enabling appropriate knowledge and information to reach knowledge intermediaries and farmers in a timely manner. Agricultural Knowledge Management strategies are built on huge agricultural content (Data- information-Knowledge). In most developing countries, agricultural institutions have not moved to a level where new and consistent information services to farmers and other stakeholders are offered based on quality and contexts. For adopting KM strategies in extension, we need to pay more attention to (1) codifying and sharing tacit (i.e. implicit) knowledge, (2) creating new knowledge and (3) having everyone in the organization involved in the process. Only then the organisation can be viewed as a living organism capable of creating continuous innovation in a self-organising manner."

The Directorate of Knowledge Management in Agriculture is committed to promote ICT driven technology and information dissemination system for quick, effectual and cost-effective delivery of messages to all the stakeholders in agriculture. Keeping pace with the current knowledge diffusion trends, Directorate is delivering and showcasing ICAR technologies, policies and other activities through print, electronic and web mode. Directorate is the nodal center for design, maintenance and updating of ICAR website along with facilitation of network connectivity across ICAR institutes and KVKs. Besides, Directorate provides public relation and publicity support to the council and its constituents across the country.

Thrust Areas

- Dissemination and sharing of agricultural knowledge and information through value added information products in print, electronic and web mode.
- Development of e-resources on agricultural knowledge and information for global exposure.
- Facilitation for strengthening e-connectivity among ICAR institutes State Agricultural Universities and KVKs.
- Capacity building for agricultural knowledge management and communication.

Using ICT in Agriculture in Egypt

In 1987, officials at the Egyptian Ministry of Agriculture and land reclamation recognized expert systems as an appropriate technology for speeding development in the agricultural sector. To realize this technology, in 1989, the ministry initiated the Expert Systems for Improved Crop Management Project (ESICM) in conjunction with the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP). The project began in mid-1989 and the Central Laboratory for Agricultural Expert Systems (CLAES) joined the Agricultural Research Center (ARC) in 1991. Through the development, implementation and evaluation of knowledge-based decision support systems, CLAES is helping farmers throughout Egypt to optimize the use of resources and maximize food production. A dozen expert systems have been developed for horticulture and field crop management. In 2000, the Virtual Extension and Research Communication Network (VERCON) project was funded by the FAO Technical Cooperation Program (TCP) to develop a Web-based information system to strengthen the link between research and extension (CLAES, 2002; FAO, 2003). This network has been extended to include other stakeholders, and other services through a project funded by Italian Debt Swap Program and executed by FAO in collaboration with CLAES (CLAES, 2008). Several expert systems have been made available on this network in addition to other modules. In collaboration with ICARDA, CLAES has developed three regional expert systems for wheat (CLAES, 2006c), faba (CLAES, 2006d) and barley (ICARDA, 2006). CLAES also developed the National Agricultural Research Management Information System (NARIMS) through a project funded by FAO/TCP. This system has five modules: Institutes Information System, Researchers Information Systems, Projects Information Systems, Publication Information System, and National Research Program Information System (CLAES, 2007).

Agricultural Knowledge and Information System (AKIS)

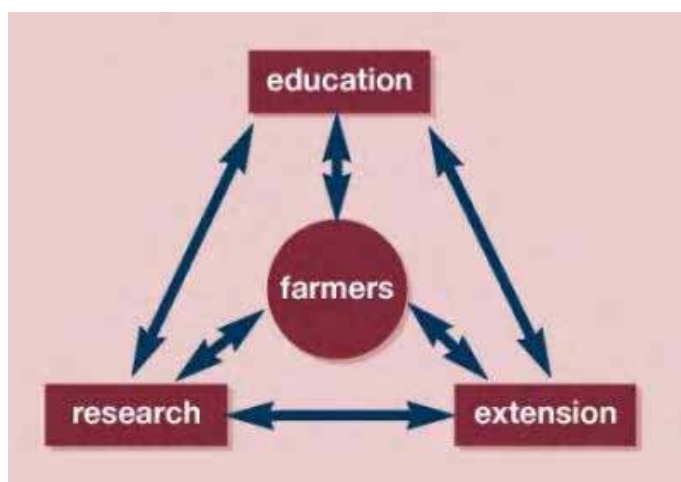
The present study provides a preliminary response to the question: How can developing countries encourage the various systems, organizations and producers concerned with agricultural research, education and extension, and operating in the public or private sector to behave as one system with regard to the agricultural development component of rural development? In other words: What do developing countries need to establish and maintain an Agricultural Knowledge and Information System (AKIS) that targets agriculture, broadly conceived as crops, livestock, fisheries and forestry as a main component of rural development (RD)? Cases studies on the present-status and direction of AKIS/RD in ten countries are reviewed and compared with a view to providing preliminary answers to this question: Following the publication of a joint FAO/ World Bank document on AKIS/RD Strategic vision and guiding principles (2000) the Food and Agriculture Organization of the United Nations (FAO) commissioned case studies of AKIS/RD in various countries. The case studies were based on almost identical terms of reference, and set out to discover the extent to which an AKIS/RD vision and principles were being perused. The case studies were carried out over the period 2000 to 2003 by national consultant in Cameroon; Chile, Cuba, Egypt, Lithuania, Malaysia, Morocco, Pakistan, Trinidad and Tobago and Uganda. In addition to gathering data on interventions

that have contributed to the development of AKIS/RD in these ten countries, FAO also held national workshop AKIS/RD in four of them - Malaysia, Pakistan, Trinidad and Tobago, and Uganda. The Organization also plans to hold an international technical meeting on AKIS/RD at same later date. The ten country case studies on AKIS/RD cover various regions South Asia, North Africa, East Africa, West Africa, the America and Eastern Europe. They also fall into three distinct economic categories as defined by the World Bank's World development indicators for 2003: low-income (Cameroon, Pakistan and Uganda); lower middle income (Cuba, Egypt and Morocco) and upper middle-income (Chile, Lithuania, Malaysia, and Trinidad and Tobago). While each consultant received almost the same Terms of Reference, every case study is distinct for the reasons already mentioned and also because the status of AKIS/RD and the issues that comfort them differ from case to case,

The present article highlights unique or innovative steps undertaken in the countries to strengthen AKIS/RD, assesses the commonalities among the countries, compare the strength and weaknesses that emerge in each case study, and reviews the lesson learned as underscored by the consultants. On the basis of this synthesis of experiences from the ten countries, the study puts forward a preliminary set of narrative guidelines for advancing AKIS/RD.

What is an AKIS/RD in brief?

An AKIS/RD is a system that links rural people and institutions to promote mutual learning and generate, share and utilize agriculture-related technology, knowledge and information. The system integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for better farming and improved livelihoods. This integration is suggested by the "knowledge triangle" displayed here.



The AKIS/RD vision document is intended as a vehicle for sharing ideas and principles with the various stakeholders addressing the causes, and for seeking solutions for rural poverty. Operational guidelines, inspired by this shared vision and consistent with the principles outlined here are under preparation by the World Bank and FAO. (Source:

<http://www.fao.org>) Agricultural and Rural Development is increasingly dependent on the efficient functioning of agricultural knowledge systems. More specifically, it depends on how the production, transmission and implementation of scientific knowledge and available technologies are managed. It is thus crucial to improve the interface between the production of knowledge and its adoption in food businesses related to agriculture, fisheries and rural areas. To that end, two initiatives developed in Spain, which are based on the use of new information technologies, can be identified as agricultural knowledge system (AKS) successes: The knowledge platform for rural areas and fisheries (MARM) and The Rural Cat of the Generalitat of Catalunya (Source: <http://www.oecd-ilibrary.org>)

ORGANIZAION OF THE STUDY

The study was organized into six main sections, beginning with the present introduction. The second section discusses the ten country case studies in terms of their different stages of AKIS and AKIS/RD development. Its Table 2 identifies 24 criteria that are utilized to rank each country's commitment to the advancement of AKIS/RD and/or the actions that countries have taken to promote this. These 24 criteria are organized into five main categories:

- (1) Policy environment
- (2) Institutional structure for supporting innovation
- (3) Conditions for expressing demand for innovation
- (4) Partnerships and networks;
- (5) Financing systems for innovation.

The original nine principles outlined' in the FAO/World Bank document are handled under these few main categories. The third section examines the strengths and weakness relevant to AKIS/RD in the ten country case studies in line with the five main categories and the 24 criteria. It then goes on to the highlight innovative features in the various country studies, and these again are organized according to the main categories. The fourth section presents lessons learned regarding AKIS/RD development each of the countries as expressed by the national consultants. The fifth section provides guidelines for strengthening AKIS/RD, drawing on the case studies and their recommendations; this discussion is also based on the five main categories. Section 6 conclusions, "from idea into action", summarizes the study and its implications for advancing AKIS/RD in developing countries. Following the conclusion, references list the country case studies and the books and articles utilized in developing the present study. Finally, the annexes include, among other things, condensed profiles of the ten countries whose case studies.

THE AKIS/RD VISION AND PRINCIPLES

Speaking the true perspective, agriculture's challenge is to achieve the integral goal of being productive, profitable and sustainable and nonpolluting. The AKIS/RD challenges this happen. The catalyst for the present review was the joint FAO/World Bank (2000) publication on developing strategic vision and guiding principles for AKIS/RD. This brief document (20 pages) outlines a vision, strategies and guiding principles for designing AKIS/RD systems. The main purpose underlying the document is to promote rural development by reducing poverty, promoting gains in agricultural productivity, and

ensuring food security and environmental sustainability in developing countries. It sets out the following four main operational purposes.

(1) To set forth a shared vision for an integrated approach to agricultural education, research and extension that would respond to the technology, knowledge information of rural people, helping them to reach informed decisions on the better management of their farms, households and communities.

(2) To facilitate dialogue with decision-makers in both government and development organizations, ensuring that proposals for investment in AKIS/RD are well founded and receive due consideration.

(3) To provide the staff of FAO and the World Bank and their Counterparts in client countries with a common set of principles to guide their work in agricultural education, research and extension.

(4) To ensure synergies from complementary investments in education, research and extension resulting in more effective and efficient systems.

The systematic and strategic vision underlying the FAO/World Bank document is focused on rural people, especially farmers, pastoralists and those who eke out a living from forestry or fishing in the present study, these people are referred to generally as "agricultural producers". Although some current trends emphasize off-farm and other income sources (AgREN E-Discussion 2004), most rural people depend directly or indirectly on agriculture for their livelihoods. The FAO/World Bank document proposes a strategic vision for an AKIS/RD that

(1) accurately identifies the constraints and opportunities facing male and female farmer" and their wider communities, through engaging scientific methods to generate appropriate economic, social and technological responses

(2) helps rural people gather the social skills and technologies needed to Augment their productivity manage their natural resources sustainably, raise their incomes, collaborate effectively with one another in addressing their common problems and become effectively involved with other stakeholders in determining the process of further technology generation and adoption

(3) enables governments to carry out activities for the public good, for example, ensuring food safety, conserving the environment reducing poverty and promoting education, research and extension, whether from Public or private suppliers

(4) provides education and continuous training and mutual learning opportunities for educators, researchers, extensionists and farmers alike, allowing them to work together effectively.

The FAO/world Bank document lays-out nine guiding principles, which are intended to assist in achieving the AKIS/RD objectives of poverty reduction, agricultural productivity gains, food security and environmental sustainability. These guiding principles are

- Economic efficiency
- Careful matching between the comparative advantage of organizations and the functions they perform
- Clear repartition of costs
- Careful assessment and optimal mixing of funding and delivery mechanisms
- Pluralistic and participatory approaches

- Effective linkages among, farmers, educators, researchers, extensionists and other AKIS/RD stakeholders.
- Building human and social resources
- Sound monitoring evaluation (M&E)

Then the question is how best to realize this vision and apply these principles. To respond to this question, the present article reviews the commonalities; lessons learned and recommendations put forward in the case studies. It also adds 15 other factors that appear essential to the successful development of AKIS/RD. On the basis of this examination, a number of normative guidelines are put forward for consideration.

To put in a nut shell, AKIS/RD is an Agricultural Knowledge and Information System for Rural Development which links people and institutions to promote mutual learning and generate, share and utilize agriculture-related technology, knowledge and information. The system integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for better farming and improved livelihoods. This integration is suggested by the “knowledge triangle” displayed below. Rural people, especially farmers, are at the heart of the knowledge triangle. Education, research and extension are services public or private designed to respond to their needs for knowledge with which to improve their productivity, incomes and welfare and manage the natural resources on which they depend in a sustainable way. A shared responsiveness to rural people and an orientation towards their goals ensures synergies in the activities of agricultural educators, researchers and extensionists. Farmers and other rural people are partners within the knowledge system, not simply recipients.

FROM AKIS AGENCIES TO AN AKIS TO AKS/RD AKIS and AKIS/RD

Strictly speaking, a successful institutional system is more than the sum of its parts (Rivera and Schram, 1987; Roling, 1989). A set of institutions becomes a “system” when its individual components are interlinked or articulated and the separate institutions are connected so that they communicate and cooperate in action to share their human, physical and financial resources in order to achieve one or more common goals.

AKIS agencies

In most countries, modern agricultural development efforts started with the establishment of research, extension and agricultural education institutions. These were frequently stand alone research institutes, universities and extension services that, in theory; maintained linkages with each other to promote the development and transfer of new technologies to farmers. However, linkages among the institutions were, often weak, while those with the clients (eg: Farmers) were even weaker. Overall performance was far below expectations which led to a need to move beyond independent AKIS agencies in order to promote rural innovation more efficiently and effectively.

The AKIS “knowledge triangle”

It is a truth that, the endeavors to articulate the set of knowledge systems or subsystems of agricultural research, extension and education into an AKIS are not new indeed the literature is replete with brooks and articles on linkages and linking of the three major agricultural knowledge systems. (In this article, these systems will henceforth, be referred to as “sub-systems”, as they are considered parts of a larger AKIS framework aimed at improving agriculture within a general concern for rural development.) In addition to the initiatives taken by FAO and the World Bank, the organization of Economic Co-operation and Development (OECD) held a major conference in 2006, which brought together directors and representatives of agriculture research, agriculture advisory service and education in agriculture to discuss what is termed Agricultural knowledge system (AKS) in September 2003, World Bank held a workshop for Eastern, European and Central Asian countries in Tbilisi, Georgia to discuss the overall reform of AKIS, while focusing on the sustainability of competitive Grant programs (World Bank, 2003).

The original diagram to illustrate AKIS/RD (Figure 1) simply highlights the three basic institutional components of AKIS/RD and the central purpose of the system to serve farmers, whom in this document are more aptly referred to as “agricultural producers”. The illustration does not point to other entities involved, such as government, the private sector civic society, support system markets etc. nor does this simplified diagram recognize the importance of AKIS/RD to users and beneficiaries other than rural producers. In addition, it implicitly emphasizes the importance of agriculture for rural development, even though it is widely recognized that agricultural innovation is important in itself and in its support for other pathways, other pathways also contribute to the development of the rural sector. (de Janvry and Sadoulet, 2001; Berdegue and Escobar, 2003; FAO, 2003).

Figure 1 was originally intended to suggest that agricultural information systems development link institutions with people (the end-users of knowledge who are agricultural producers) to promote learning AKIS/RD strategic vision guiding principles (FAO/World Bank, 2000) proposes generating, sharing and utilizing agriculture related technology, knowledge and information in a strategically aligned system. Such a system integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for better farming and improved livelihoods, as well as regional and national stability and growth. This integration is needed now more than ever, challenges of competing in a globalized economy and building competitive advantages aimed at global agricultural market opportunities:

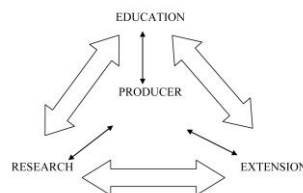


Figure 1: Agricultural Knowledge and information system for Rural Develop

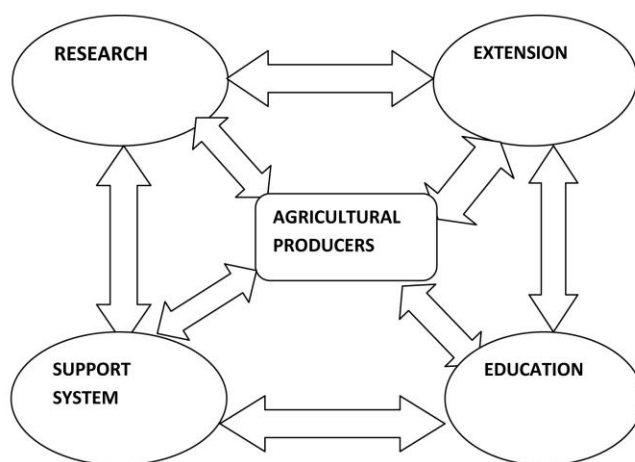
AKIS/RD development

Other ideal models of AKIS/RD that have been put forward are more inclusive of the contextual and environmental systems involved. One such model, which was used by the consultant for the Pakistan case study, illustrates four major subsystems and their idealized information follows

- (1) the knowledge creation subsystem
- (2) the knowledge diffusion subsystem
- (3) the knowledge utilization subsystem
- (4) the agricultural support subsystem involve in credit, input and market functions.

Given inclusiveness of the AKIS/RD vision, if both public and private entities to operate within the four subsystems, the Pakistan model, (adapted to place agricultural Producers at its center) offer a more comprehensive model that includes agricultural support systems such as credit institutions, supplies and markets (Figure 2).

Figure 2 : An idealized AKIS/RD model



The Pakistan model might be further shaped to include relevant non-system components, such as government policy institutional commitment, communication systems other than those assisting extension and other relevant physical and human resources, as shown in Figure 3. This model, which illustrates the various components surrounding and influencing an AKIS/RD, is a more comprehensive rendering of the idealized AKIS/RD model, bringing together the various main actions with an impact on AKIS/RD and the specific subsystems that comprise the system. Although the addition of these components (policy, physical and human resources communications and institutional commitment) may render the model slightly messy, Figure-3 nonetheless suggests the numerous elements in AKIS/RD. In fact, it could be made messier in that the policy, physical and human resources, communications and instructional elements should be connected to each of the four main sets of institutions research, extension, education and support

systems which themselves should include both public and private sector entities. In reality Figure 3, would more likely look like a web of crisscrossing connections.

Rural development

Rural development includes, but is broader than, agriculture and its development indeed, non-agricultural activities such as micro-enterprise development are priorities within the rural development strategies of international agencies, such as the Inter-American Development Bank (Echeverria, 1998). However, agriculture remains central to rural development. Most rural populations are engaged in some form of agricultural development and although agricultural pursuits may not comprise the majority of all endeavours undertaken by rural people, they represent a plurality among the income-generating activities pursued by rural populations.

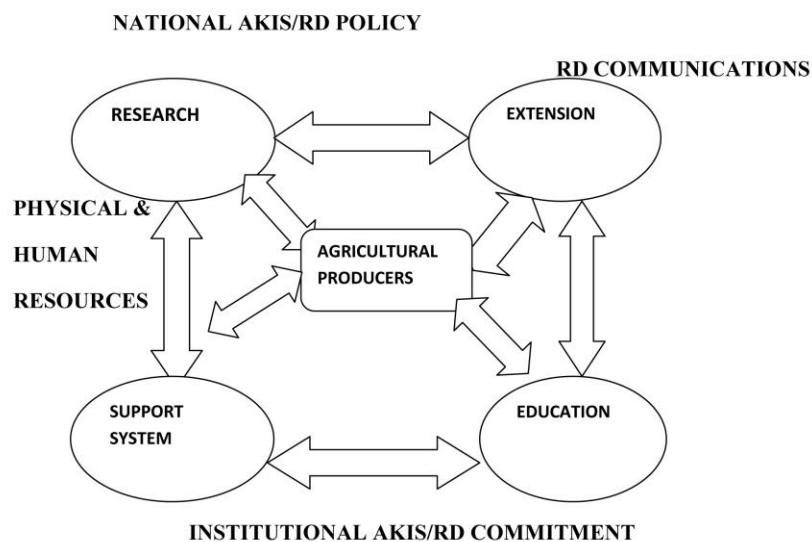


Figure 3 : A comprehensive AKIS/RD model

INSTITUTIONAL AKIS/RD COMMITMENT

International publications suggest that productivity gains in agriculture are essential for reducing poverty (World Bank, 2002). Agriculture is the main source of income for large numbers of people and provides the basic food subsistence needs for the majority of the population in these countries as well as being a main source of income for governments that exploit food and fiber products (FAO, 1990). In the Malaysia case study, as with other upper middle-income developing countries, the agriculture sector is currently regarded as a strategic sector. For many low-income countries, agriculture is and will remain for the foreseeable future the main sector producing exportable goods. Agriculture will also remain crucial for trade in many middle and high income countries (Brown, 1994) some two

thirds of the people in sub-Saharan Africa depend on agriculture for their livelihoods (Eicher, 2004)

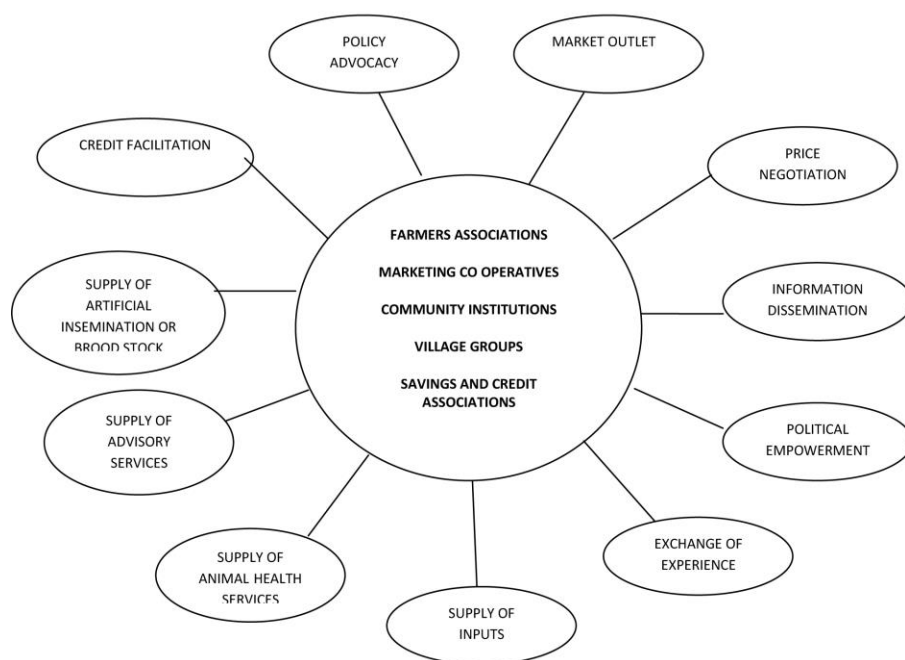


Figure 4: the multifaceted advantages of producer and community organization

In order to advance agricultural development governments with the assistance of international organizations are beginning to promote decentralized programmes, including subsidiary approaches that provide communities and rural producers organizations with the potentials to develop their own programmes for local development (Mercoiret et al., 2001). The World Bank promotes projects that empower rural people via community driven development (CDD), which encourages communities to move towards self-determination. These GDD projects assist communities to formulate proposals that are then reviewed and, if accepted funded.

In Denmark, experience confirms that small-scale producers can gain tremendously from organizing and working together to identify their needs and consolidate their demands. Producer organizations that are owned and controlled by the producers themselves have the potential to empower farmers and facilitate the delivery of services that respond to their needs and fulfill the required standards of quality. Figure 4 shows a sample of the multifaceted advantages that producer organizations and community institutions can offer the members. In some cases, governments have initiated efforts to establish nationality integrated and multispectral extension networks to combat food insecurity. These incipient national system networks include public and private for-profit and not-for-profit organizations, as well as international project aimed at food security goals. Some governments have created partnerships with other sectors of society, including multi-sectoral providers of extension and information services, in order to foster the conditions to

end hunger. These governments expect a food securing strategy to increase domestic food security and, eventually to facilitate inter and intraregional trade in food items. They understand that, when organized, poor farmers (i.e agricultural producers who are underprivileged) can produce beyond their own needs and enter the export market.

As we learned the glimpses of Knowledge Management Systems, now let's see the Content Management Systems in brief. Common website problem we often encounter are the following:

- No updating – static websites are difficult to update.
- No search function – users can not search your site to find content they are looking for.
- Limited Features– user login, forums, mailing lists features require custom code to implement and expensive to implement.

Content Management System (CMS)

A content management system is software that keeps track of every piece of content on your Web site, much like your local public library keeps track of books and stores them. Content can be simple text, photos, music, video, documents, or just about anything you can think of. A major advantage of using a CMS is that it requires almost no technical skill or knowledge to manage. Since the CMS manages all your content, you don't have to.

List of CMS

- Joomla
- Drupal
- Wordpress
- E-Z Publish

Open-source software is software whose source code is published and made available to the public, enabling anyone to copy, modify and redistribute the source code without paying royalties or fees. Open source code can evolve through community cooperation. These communities are composed of individual programmers as well as very large companies. Many of these individuals' programmers who start an open source project usually end up as large companies with open source programs. Examples of open-source software products are 7-Zip file archiver, Eclipse, OpenOffice.org, Joomla.

What is Joomla?

Joomla is an award-winning content management system (CMS), which enables you to build Web sites and powerful online applications. Many aspects, including its ease-of-use and extensibility, have made Joomla the most popular Web site software available. Best of all, Joomla is an open source solution that is freely available to everyone. Joomla! website brings together three elements

- Your content, which is mainly stored in a database.

- Your template, which controls the design and presentation of your content (such as fonts, colours and layout).
- Joomla! which is the software that bring the content and the template together to produce webpages.

Features of Joomla

- User Management
- Media Manager
- Language Manager
- Banner Management
- Contact Management
- Polls
- Search
- Syndication and Newsfeed Management
- Menu Manager
- Template Management
- Integrated Help System
- Powerful Extensibility
- Content Management
- Web Links Management

What joomla can do ?

- Corporate Web sites or portals
- Corporate intranets
- Online magazines, newspapers, and publications
- E-commerce and online reservations
- Government applications
- Small business Web sites
- Community-based portals
- Personal or family homepages
- School and church Web sites
- Non-profit and organizational Web sites

What is Joomla made up of?

- Components
- Modules
- Plugins
- Templates
- Core Libraries

Advnatages of Joomla

- Free and open source
- Full fledged CMS
- More powerful and robust than wordpress
- Admin out of the box, much more than just articles
- SEO Friendly
- Huge set of extensions

Disadvantages of Joomla

- Bigger learning curve
- Wordpress is better for simpler sites
- May need a developer for some of the changes

Joomla Useful Links:

- <http://extensions.joomla.org>
- <http://developer.joomla.org>
- <http://docs.joomla.org>
- <http://api.joomla.org>

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An ICT Module on Microfinance and Coastal Indebtedness in Indian Marine Fisheries Sector

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The extent of coastal rural indebtedness in the marine fisheries sector is quite observable throughout the Indian coastal belts. The Micro Finance Institutions (MFI)/Self Help Groups (SHG) mobilised in marine fisheries sector do play a vital role in reducing the vicious circle of indebtedness among marine fisherfolk. An exact assessment on the indebtedness level has not so far been attempted among marine fisherfolk. The extent and quantum of indebtedness at a reasonable level of interest sourced out from the organised sector is an indicator of development since availability of finances boosts up the economic activity and capital formation in a region. The extent of indebtedness and the average outstanding debt per indebted households are comparatively less among fishermen as per the figures of institutional sources, but the affairs of the fisherfolk is really grim as they are virtually gripped in the hands of non-institutional agencies, namely the money lenders and traders for which legitimate data sources do not exist. Fisherfolk are attracted to the non-institutional agencies on account of simple procedures and timeliness in availing finance and for operational expenses which ultimately make them suffer from debt trap and vicious circle of indebtedness. Even when Fisheries sector possesses a major role in earning foreign exchange, the fisherfolk are still in the lower strata of the society because of indebtedness and are in the clutches of non institutional credit agencies. As cheap credit is always essential for development of Indian marine fisheries sector with a coast line of 8129 km, MFIs play a distinct role in this regard to offer low cost credit and thereby save the fisherfolk from permanent debt trap. The importance of the study in this regard is to assess the extent of indebtedness among marine fisherfolk in mechanized, motorized and traditional sectors on the impact assessment of Microfinance on rural indebtedness in marine fisheries sector as well as and the role of credit agencies in providing credit, the credit utilization pattern as well as repayment behaviour of marine fisherfolk for better ecosystem management and ensuring sustainable development of the Indian marine fisheries sector.

Mammoo (2004) in a study on income, indebtedness and savings among fisherfolk of Udayapur and Gopalpur of Odisha under BOBP Programme said that fishing communities know two distinct credit sources: the traditional/informal and the institutional/formal. Traditional sources include moneylenders, middlemen, fish traders, boat owners, shopkeepers and pawn brokers. Institutional sources are mainly banks and cooperatives. Khan et al. (2005) in a case study undertaken on fisheries sector indebtedness in Baluchistan and Sindh of Pakistan, observed an empirical link between poverty and indebtedness and the mean debt to income ratio in low income group of fisherfolk was 3:4. Yunus (1999), the pioneer of microfinance projects in *Bangladesh* said the microfinance system enabled thousands of people by offering poor people loans, some fear it could lead to over-*indebtedness*, but microfinance has benefited the wider economy. Dynamics of twelve women's Self Help Groups in Marine fisheries sector of Malabar area of Kerala was studied and a strategy for mobilisation of an effective Self Help Group was developed by Vipinkumar (2007). Sathiadhas (2009) has conducted micro level socio economic studies on indebtedness in selected fishing villages in different maritime states in India. Jayaraman (2005) undertook the performance analysis of fisherwomen Self Help Groups in Tamil Nadu and reported that women SHGs played a substantial role in alleviating poverty and indebtedness in fisheries sector. Tripathi and Sharma (2007) conducted impact assessment of SHG-Bank Linkage Programme on Financial Behaviour of Rural Poor in Raebareli District in Uttar Pradesh to address the issue of sustainable development of the rural poor through SHG-Bank linkage using participatory approach. The livelihood analysis encompasses all the strategies and assets that individuals and households use to earn a living of which, micro finance plays a vital role. (CBCRM Resource Center (2003); Arciaga *et al*, (2002); Ashby (2003), NSSO (2003), Ministry of Finance (2007) and CED (2008) brought out the reports of indebtedness level in the Indian agricultural sector. Kudumbashree (2010) of Kerala state has spent Rs 121.88 crores for microfinance enterprises for women empowerment. In this context, the MFIs/SHGs of fisherfolk do have a pivotal role in reducing the indebtedness in the marine fisheries sector.

The present study was undertaken with the following objectives.

- To assess the extent of rural indebtedness and the role of various agencies in providing credit, the credit utilization pattern and repayment behaviour in marine fisheries sector.
- To study the impact of selected Microfinance Institutions/ Self Help Groups on rural indebtedness, supply of credit and empowerment of marine fisherfolk and elucidation of success cases of microfinance in entrepreneurial capacity building and thereby develop an Information Communication & Technology (ICT) Module on impact of microfinance on coastal indebtedness in Indian marine fisheries sector.
- To study the comparative appraisal of perception of fisherfolk on MFIs, Institutional and Non institutional credit sources in terms of selected attributes.

Methodology

Assessment of the extent of indebtedness among marine fisherfolk in mechanized, motorized and traditional sectors and the role of credit agencies in providing credit and the impact assessment of MFIs on coastal rural indebtedness, the credit utilization pattern and repayment behaviour in marine fisheries sector, supply of credit and empowerment of

marine fisherfolk and elucidating success cases of MFIs in entrepreneurial capacity building were the major aims. The project was undertaken in the entire coastal belts of India covering four zones such as North East, North West, South East and South West zones. The North East zone covered the states Odisha and West Bengal, North West zone covered Maharashtra and Gujarat, South East zone covered Tamil Nadu and Maharashtra and South West zone covered Kerala and Karnataka states. The map showing the locale of the study is presented in figure 1.



Figure 1: Map of Indian coastal belts showing the locale of the study

Situational analysis was undertaken through PLA in the selected potential maritime locations in the above mentioned zones and the marine fisherfolk from the various strata such as mechanized, motorized and traditional sectors will be taken as representative samples by random sampling method. A detailed study was made through personal interview of the fisherfolk to assess extent of coastal rural indebtedness and the role of various credit agencies in providing credit, the credit utilization pattern and repayment behaviour of marine fisherfolk with the help of a pre-tested and standardized data collecting protocol. In addition to this, the situational analysis took care of identification of MFI/SHGs mobilized in marine fisheries sector with fishery based micro enterprises or allied sector micro enterprises through PLA and systematic data collection processes. Any mobilized group venture with a productive economic activity initiated by thrift deposits and sustained by an appropriate micro-enterprise either independently or by the intervention of an external agency is considered an MFI for the study. This included SHGs also which finished the gestation period of 36 months with an economic activity initiated through thrift deposits and sustained by an appropriate micro-enterprise promoted by micro-finance either independently or by the intervention of an external agency like NGOs, private micro financial firms, banks etc. The dynamics of credit utilisation pattern, repayment behaviour and extent of debt redemption of the members of these MFIs were

assessed and the important dimensions contributing to their effectiveness were identified and thereby the present prospects and the constraints faced by MFIs in marine fisheries sector were documented. Data were gathered through personal interview with the pre-tested and standardized data collecting protocol from members of 12 selected MFIs in each state and non-members in marine fisheries sector comprising of 600 respondents from each state (Grand total 4800) to assess their impact on indebtedness level, supply of credit and empowerment. Success cases of MFIs on entrepreneurial capacity building which played a significant role in the poverty alleviation and debt redemption were also documented and the whole results were brought out as the ICT module which is a compilation of interactive multimedia cyber extension package consisting of video clippings, 2 D and 3 D animation movies, audio records, still picture gallery, ICT based presentations and synergies and outlines represented by full text of the 'e book' on microfinance on coastal indebtedness.

Similarly to study the comparative appraisal of perception of fisherfolk on MFIs, Institutional and Non institutional credit sources in terms of selected attributes, respondents were asked to assign ranks to each of the attributes to make comparison. The data obtained from the respondents were systematically tabulated for the purpose of analysis Garrett's Ranking Technique was used to identify and rank the attributes on the functioning of MFIs. Garret's ranking technique provides the change of orders into numerical scores. The prime advantage of this technique over simple frequency distribution is that the reasons and factors are arranged based on their importance from the point of view of respondents. The per cent position of each rank was converted into scores referring to the Table given by Garret and Woodworth (1969). Garret's formula for converting ranks into percent is given below:

$$\text{Percent position} = 100 * (R_{ij} - 0.5) / N_j$$

Where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th} individual

For each factor, the scores of individual respondents were added together and divided by the total number of the respondents for whom scores were added. The mean scores for all the factors were arranged in descending order, ranks were given and the most important factors or reasons were identified. Thereby the comparative appraisal of MFIs, Institutional and Non Institutional credit agencies was made.

Results and Discussion

This study highlighted the indebtedness level of MFIs and non MFIs in Indian marine fisheries sector by taking into account 4 maritime zones covering 8 states. The major findings are synergised and presented as summarised tables and figures as follows. In general, the level of indebtedness and repayment percentage across the sectors of members of MFIs and Non MFIs are presented in tables 1 and 2 respectively as the comprehended results of the entire study.

Table 1: Level of indebtedness across the sectors of members of MFIs and Non MFIs

Zone	Level of indebtedness in Rupees (Lakhs)					
	Mechanised sector		Motorised sector		Traditional sector	
	Member MFI	Non member MFI	Member MFI	Non member MFI	Member MFI	Non member MFI
South West	0.68	1.95	0.44	1.64	0.50	0.37
South East	0.89	1.09	0.54	0.89	0.50	0.71
North West	0.28	0.40	0.19	0.25	0.12	0.08
North East	1.63	2.05	1.35	1.75	0.21	0.69

Table 2: Level of repayment across the sectors of members of MFIs and Non MFIs

Zone	% of Repayment of loans					
	Mechanised sector		Motorised sector		Traditional sector	
	Member MFI	Non member MFI	Member MFI	Non member MFI	Member MFI	Non member MFI
South West	14.10	26.75	40.52	22.60	32.00	14.00
South East	25.00	19.60	27.50	26.00	20.00	24.50
North West	10.00	12.00	8.00	8.00	12.00	6.00
North East	25.00	23.00	28.00	26.00	22.00	13.50

The study undertaken in South West zone, with 600 samples in Kasargod, Calicut and Ernakulam districts of Kerala state showed the average indebtedness of fisheries households in mechanised sector of non members of MFIs is Rs 1.95 lakhs and that of members is Rs 0.68 lakhs. In motorised sector, the indebtedness of non-members is Rs 1.64 lakhs and that of MFI members is Rs 0.44 lakhs. But in the traditional sector, the MFI members' indebtedness is Rs 0.50 lakhs and that of nonmembers is Rs 0.36 lakhs which indicates the necessity of strengthening the MFI ventures in the traditional sector. In the secondary sector, level of indebtedness of MFI non members is Rs 1.96 lakhs and that of members is Rs 0.80 lakhs. In the secondary sector, level of indebtedness of MFI non members is Rs 1.20 lakhs and that of members is Rs 1.10 lakhs. With regard to mariculture sector, level of indebtedness of MFI non members' was Rs 0.76 lakhs and that of members

was Rs 0.58 lakhs. It was also observed that the repayment capacity of MFI member fisherfolk was to the tune of 39 %. The study done in Karnataka state of South West zone, with 600 samples from the various sectors from Mangalore Fisheries harbour, Dakshina Kannada district showed the average indebtedness in the primary sector as Rs 4.25 lakhs, that in the secondary sector as Rs 3.42 lakhs and that in tertiary sector as Rs 0.32 lakhs. The case studies elucidated from Manjunatha SHG, Dakshina Kannada district, and the MFI 'Mathsya', Navodaya, Amrithavarshini and Bhramambika, revealed that the MFIs scored high in all the attributes and all members expressed maximum satisfaction over the performance of MFI which brought about a socio-economic transformation, poising towards a higher standard of living in their livelihoods.

The study undertaken in South East Zone comprised 600 samples in Nambuthalai, Ervadi, Thirupalaikudi north, Vedalai, Victoria nagar Susaiyapparpattinam and Olaikuda in Ramanathapuram district and Tharvikulam, Tuticorin and Punnakkayal of Tamil Nadu from mechanised, motorised and traditional sector and MFIs. Majority of marine fisherfolk are indebted to fish traders and boat owners followed by banks and private moneylenders. Bank levied 7 to 14 per cent interest, whereas microfinance institution levied 7 to 16 per cent interest on the principle amount. Private moneylender levied 24 to 60 per cent interest on the principal amount, interest repayment by the borrowers were either weekly or monthly. MFIs significantly reduced the dependence of fisherfolk on private moneylender, considerably reduced the indebtedness level and increased their repayment capacity. MFIs assisted the fisherfolk in meeting their expenditure on purchasing of nets, repairing boats and for buying other accessories. It was observed that 39 per cent of marine fisherfolk population was indebted to fish traders followed by 37 per cent in banks. The study found that 26 per cent of SHGs were able to repay 81-100 per cent of the loan which they borrowed. The South East Zone also comprised 600 samples from mechanized fishing families at Visakhapatnam fishing harbor and motorized/non motorized fishing families at Lawson's bay fishing village, Visakhapatnam, Annavaram, Bheemlipatnam, Uppada and Kappudibbulapalam villages. The results showed the level indebtedness among fisherfolk in mechanised sector 65 per cent and that in motorised sector is 59 per cent. It was also observed that the MFI member fisherfolk of DWCRA had tremendous repayment capacity of the loans. The level of indebtedness got reduced to the tune of 75 per cent after joining MFI and their repayment capacity improved to the extent of 65 per cent in mechanised sector. In motorized sector, the level of indebtedness increased to the tune of 65 per cent after joining MFI, but in the mean time the repayment capacity also got improved to the extent of 53 per cent.

In the North West zone, the study undertaken in Versova of Greater Mumbai district, Achra and Vengurla of Sindhudurg district, Ratnagiri, Thane and Raigad districts of Maharashtra from 600 samples comprising mechanised (45per cent), motorised (30 per cent) and traditional (25 per cent) showed that the level indebtedness among fisherfolk is 21 per cent among nonmembers of MFIs (Vipinkumar and Shyam, 2013). Similarly, in Gujarat state of North West Zone, Porbunder and Veraval locations have been selected for data collection from mechanized, motorised and traditional fisherfolk of members and nonmembers of MFIs comprising a total of 600 respondents. The level of indebtedness is 19 per cent and it is lesser for members of MFIs and their repayment capacity is to the tune of 26 per cent. There

existed a significant difference in the level of indebtedness across the member fisherfolk of MFIs and non-members on account of their higher repayment capacity, less risk involved and easiness in availing credit.

The study undertaken in North East Zone comprised 600 samples each from West Bengal and Orissa states. The selected locations are Diga, Contai, Junput and Dadunpatra and Kakadwip in West Bengal and Aryapilly and Gopalpur of Ganjam district and Astrang and Konark of Puri district and Jagatsinghpur and Balasore areas of Orissa state from mechanised, motorised and traditional sector and MFIs. MFIs significantly reduced the dependence of fisherfolk on private moneylender, considerably reduced the indebtedness level and increased their repayment capacity. The results showed the level indebtedness among fisherfolk in mechanised sector 32 per cent and that in motorised sector is 24 per cent. It was also observed that the MFI member fisherfolk have good repayment capacity to the tune of 29 per cent in West Bengal and 36 per cent in Orissa. The level of indebtedness got reduced to the tune of 36 per cent after joining MFI and their repayment capacity improved to the extent of 56 per cent across the sectors.

With regard to the savings and level of indebtedness across the states, the table 4 shows the frequency of respondents having savings and the level of indebtedness. The figure 2 also shows the level of indebtedness across states. The highest indebtedness is noticed in the state of Orissa (89 per cent) followed by West Bengal (88 per cent). The least indebtedness is noticed in Maharashtra (78 per cent).

Table 3 : Savings and Level of indebtedness across states

No	States	Frequency of respondents having Savings				Total	Level of Indebtedness (%)
		Nil	< 0.5 L	0.5 -1 L	>1 L		
1.	Maharashtra	468	104	20	8	600	78
2.	Karnataka	510	60	24	6	600	85
3.	Kerala	498	82	16	4	600	83
4.	Tamil Nadu	522	60	16	2	600	87
5.	Andhra Pradesh	474	96	22	8	600	79
6.	Orissa	534	50	16	0	600	89
7.	West Bengal	528	54	18	0	600	88
8.	Gujarat	486	88	26	0	600	81
	Total	4020	594	158	28	4800	83.75

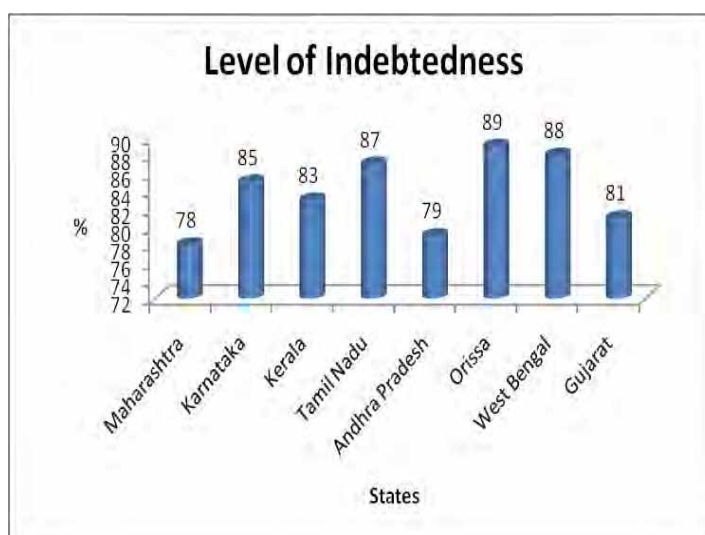


Figure 2 : Level of Indebtedness across states

Similarly the sources of credit when compared across the states, it was found that the banks were the major source of loans followed by private money lenders and co-operatives shown in Table 4 and Figure 3. However it varied from state to state, in such a way that the major source in Kerala was Co-operatives and Orissa, West Bengal and Gujarat topped for private money lenders. When all the maritime states were pooled together, the major source in general became banks.

Table 4: Sources of credit across the states

No	Sources	MH	KNT	KER	TN	AP	OR	WB	GUJ	Total	%
1	Banks	372	386	132	204	94	194	178	84	1644	42.26
2	Co-operatives	22	52	192	38	116	36	42	48	546	14.03
3	Private money lenders	26	26	124	200	126	204	218	248	1172	30.12
4	Friends / Relatives	10	4	2	4	46	38	36	72	212	5.44

5	Fish traders	8	8	6	42	4	8	12	4	92	2.36
6	Boat owners	4	4	2	4	4	6	8	4	36	0.92
7	Shop keepers	4	4	2	4	2	4	10	2	32	0.82
8	Jewel loans	2	6	16	10	64	38	14	6	156	4.05

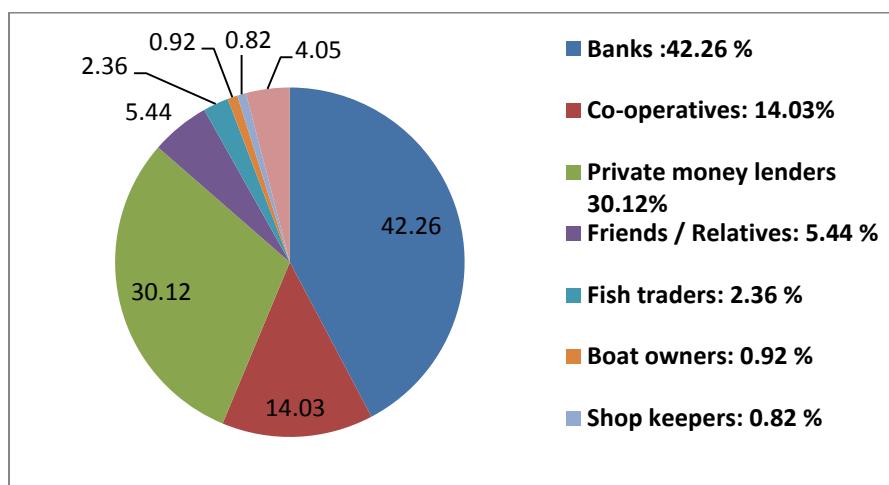


Figure 3: Sources of credit across the states

Similarly the purposes of credit throughout the maritime states in the four different zones were compared in the table 5 and figure 4.

Table 5: Purpose of credit across the states

No :	Purpose	States									%
		MH	KNT	KER	TN	AP	OR	WB	GUJ	Total	
1	Purchase of craft/ gear and other fishing related equipments & repair	252	252	120	76	206	320	394	494	2114	48.28
2	House construction / Land purchase	6	30	312	104	54	142	38	12	698	15.94

3	Marriage expense	14	24	80	40	102	6	34	4	304	6.94
4	Education	10	14	18	36	102	4	12	6	202	4.61
5	Health and Social Security	10	8	22	32	4	46	6	38	166	3.79
6	Any others (business, purchase of vehicles)	204	224	12	286	48	48	50	22	894	20.44

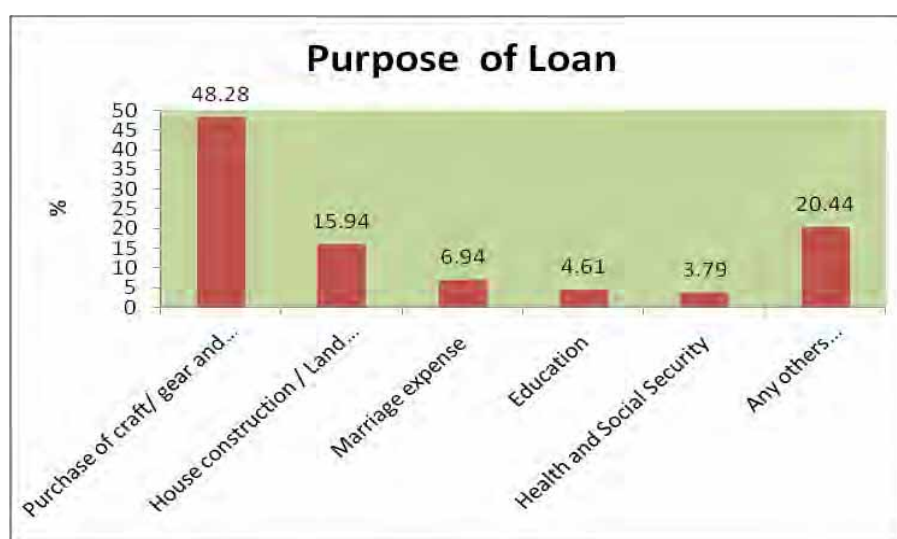


Figure 4: Purpose of credit across the states

Examining the table 5 and figure 4, it could be observed that more than 50 per cent of loans were used for Non Performing Asset (NPAs) creation other than fishing related items and only 48.3 per cent was used for purchase of craft/ gear and other fishing related equipments & repair. This can be considered an introspection of purposes of credit being utilised in the marine fisheries sector across the maritime states of the country.

Development of ICT Module

As a part of the second objective, an Information Communication Technology (ICT) Module was developed on impact of microfinance on coastal indebtedness. This is an interactive multimedia cyber extension module on Microfinance Institutions /Self Help Groups in the marine fisheries sector of Indian coastal belts. Success cases of MFIs on entrepreneurial capacity building which played a significant role in the poverty alleviation and debt redemption were also documented and the whole results were brought out as the ICT module.

The content of ICT module:

The ICT module developed was the first of its kind which is a compilation of interactive multimedia cyber extension package consisting of video clippings, 2 D and 3 D animation movies, audio records, still picture gallery, ICT based presentations and synergies and outlines represented by full text of the 'e book' on microfinance on coastal indebtedness synchronized with visual effects and entertaining background music. The entire package is made available in a DVD and on clicking the respective component; the viewers can enter the arena of each component of cyber extension package as per their preference. The components of the module are as follows:

Video clippings:

The ICT module consisted of eight short movies on the impact microfinance and coastal indebtedness, two each representing the zones identified for the project such as North East, North West, South East and South West zones. The viewers on clicking the respective locations of the maritime state or the zone, the movies will be projected pertaining to that particular zone.

Animation movies:

The ICT module covered 2 dimensional and 3 dimensional animation movies on microfinance and self help groups with sketches and diagrammes drawn by the artists of the Socio Economic Evaluation & Technology Transfer Division of CMFRI depicting the formation, stabilization and self-helping phases of Self help groups and the impact of microfinance institutions on coastal indebtedness.

Audio records:

Another component of ICT module was the audio records of microfinance and importance of Self Help Groups mobilisation with dubbed voices of professionals. Extreme care was taken to use the human resources of the division, to reduce the expenditure. The audio narrates the genesis and different phases of SHGs such as group formation, stabilization and self helping phases and the strategy for mobilising an effective Self Help Group.

Picture Gallery:

The still picture gallery of the ICT module consisted of the still photographs taken throughout the coastal belts of the country on the project work on coastal rural indebtedness and impact of microfinance in the marine fisheries sector in two different sections such as Orissa, West Bengal, Andhra Pradesh and Tamil Nadu of east coasts and Kerala, Karnataka, Maharashtra and Gujarat of west coasts with titles.

ICT based presentations:

The ICT oriented presentations covered the power point slide presentations used in various stages of project conceptualization and approval to the final results of the project with expert supervision on the quality on the slides which can be used as a manual for subsequent research on microfinance and Self Help Groups concerned with indebtedness as a practical reference material.

Synergies and Outlines:

The last component of the ICT module entitled as synergies and outlines on clicking will lead to the full text of the project report in the PDF version which was released as the 'e book' of CMFRI entitled 'Coastal Rural Indebtedness and Impact of Microfinance in Marine Fisheries Sector' by the Hon. Director General, ICAR, Dr.S.Ayyappa at Mandapam Regional Centre of CMFRI. The results of the study revealed Odisha as the state with

highest level of indebtedness (89 per cent) and Maharashtra as that with the least level of indebtedness (78 per cent). The study also showed that the level of indebtedness of members of MFIs was less compared to the non-members. Though the indebtedness was more in certain cases, the level of repayment was found to be significantly improved in MFIs. In the traditional and tertiary fisheries sectors, there is an extreme necessity of strengthening the MFI ventures. Success stories documented on entrepreneurial capacity building, debt redemption and poverty alleviation in the ICT module can serve as a practical manual/case model for mobilizing MFIs in any key areas for the ecosystem management and sustainable development in the Indian marine fisheries sector.

Appraisal on the functioning of the MFI / Institutional / Non - Institutional credit agencies

As the third objective, an appraisal of the attributes for institutional, non-institutional and micro-finance has been evaluated by Garret and Woodworth ranking and found that MFIs were better in many of the attributes compared to other sectors for all the states holistically when taken into consideration (Table 6).

Table 6: Appraisal on the functioning of the MFI / Institutional / Non - Institutional credit agencies

S.No	Attributes	Institutional		Non Institutional Credit		Micro Finance Institution	
		Score	Rank	Score	Rank	Score	Rank
1	Easy approval process	53.7	II	40	III	57.0	I
2	Diverse areas of funding	46.3	II	43.4	III	62.8	I
3	Eligibility of recipients	62.8	I	50.0	II	37.2	III
4	Maximum loan amount	45.4	II	56.0	I	41.9	III
5	Need for collateral security	55.9	I	51.3	II	41.9	III
6	Provision of longer loans	51.3	II	41.5	III	56.3	I

7	Provision of loan grace periods	52.5	II	42.4	III	55.5	I
8	Easy repayment schedule	52.9	II	40.7	III	54.6	I
9	Low interest rate	56.7	I	42.4	III	46.6	II
10	Stringent for default of payment	44.9	II	59.2	I	44.1	III
11	Hidden cost and concerns	49.5	II	59.0	I	41.4	III

Conclusion

The study makes an attempt on the assessment of the extent of indebtedness among marine fisherfolk in mechanized, motorized and traditional sectors and the perceived impact assessment of Microfinance Institutions (MFI) on coastal rural indebtedness and developing an ICT module on impact of MFIs on coastal indebtedness. Tripathi and Sharma (2007) conducted an impact assessment of SHG-Bank Linkage Programme on Financial Behaviour of Rural Poor in Raebareli District in Uttar Pradesh to address the issue of sustainable development of the rural poor through SHG-Bank linkage using participatory approach. The study also revealed that fishermen are most often trapped under debt to fish traders and they are not able to come out from the trap. Microfinance institutions/ Self Help Groups significantly reduced the dependence of fisherfolk on private money lenders and considerably reduced the indebtedness level and increased their repayment capacity. The results of the study are in agreement with impact assessment study of MFIs in Karnataka coastal belts. (Vipinkumar and Swathilekshmi, 2012, Vipinkumar *et al*, 2013) MFIs considerably assisted the fisherfolk in meeting their expenditure on purchasing of nets, repairing boats and for buying other accessories. It could be observed that the level of indebtedness in MFIs is less compared to non MFIs and the level of indebtedness in non MFIs is almost 3 times of MFIs. At times, even when the indebtedness was high, the repayment capacity of MFIs was found to be more. Banks were found to be the major source of funding followed by Private money lenders. Non-institutional credit agencies still hold good across the sectors. NPAs existed to a great extent as loans are being used for non-fisheries activities like asset creation and social obligations. Vasantha and Manohar (2008) reported that microfinance programmes are presently being promoted as an important strategy for concurrently addressing both poverty alleviation and women's empowerment and micro financial firms must maintain efficiency levels to increase their scale of operations which surely will bring down the cost of financing and ultimately the benefits will be transferred to the poor people in terms of improving the standard of living and reasonable cost of borrowing. Another important inference which could be drawn from the study was that, as the repayment percentage of MFIs in the traditional sector was not up to the mark

compared to non-MFIs, there is an extreme necessity of strengthening the MFIs in the traditional sector because 91.3 per cent of the fisherfolk households come under the category of traditional sector in Indian marine fisheries census. It was observed that 37 per cent of active fishermen involved in mechanised fishing corners 66 per cent of catch and earnings and another 36 per cent of in motorised sector gets 27 per cent catch and earnings. The rest, 27 per cent involved in traditional sector gets only 7 per cent catch and proportionate earnings which is constituted by 91.3 per cent of the fisherfolk population of the country. (CMFRI, 2010) Therefore, concerted efforts in this direction to strengthen SHGs in the traditional sector are inevitable for better entrepreneurial capacity building through mobilized microfinance ventures. The success case studies elucidated on entrepreneurial capacity building, debt redemption and poverty alleviation through the ICT module developed as a part of this study in turn can serve as a practical manual for mobilizing MFIs in any key areas for the efficient ecosystem management and sustainable development in the Indian marine fisheries sector.

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Importance of Participatory GIS (PGIS) Tool in Marine Fisheries

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Public Participation GIS (PPGIS)/Participatory GIS (PGIS) is a term that has been coined to express the adoption of GIS to empower indigenous and local communities. Through this the stake holders with contribution of their traditional knowledge and experience are directly involved in the planning and decision making on agriculture, forestry, fisheries, animal science *etc.*, Most of the planning in rural and urban development, agriculture and forestry are being explained on the basis of mapping. So it is imperative that the stake holder should have say into the policy making and they should understand the significance of mapping. It is believed that without access to GIS and its analytical capabilities and popular appeal, ordinary people would find it difficult to respond to official policies that alienate them. PGIS initiative focuses on generic issues such as empowerment and equal representation. The movement represents the vision of GIS practitioners who have developed an interest in the socio-political contributions that the technology can make to empower less privileged groups in society. PGIS is therefore about the role of GIS in a broader consideration of the empowerment of communities. Recorded benefits of PGIS projects thus include advocacy of popular causes, a better understanding of local issues, and accessibility of communities to digital spatial information.

Some of the classical concept of the authors working on the possibilities of GIS in socio economic development are given below:

- Geospatial technologies place an inordinate amount of attention on quantitative data at the expense of qualitative information. They are also prone to obscure technical processes that go into the generation and representation of spatial data ("garbage in, garbage out"), leading to misinterpretations about their accuracy and validity (Pickles 1995).

- Geospatial technologies play a central role in surveillance, warfare, and invasion of privacy by government and business, which calls into question their scientific neutrality and objectivity (Curry 1995, 1998).
- Scientific researchers and policy makers have an ethical responsibility to ensure that geospatial technologies are developed and applied in ways that make them accessible to all communities, particularly socially disadvantaged groups, and that promote justice and progressive change in society (Chrisman 1987, 2005; Harris and Weiner 1998; Schuurman 2000).
- GIS is not simply a branch of information science of interest only to technology specialists. Over the last four decades, GIS has literally transformed how political, economic, cultural, and legal institutions function in the United States and around the world. It also has brought on a revolution in earth science, planning, and development research (Dobson 1993; Goodchild 1992).
- Given its importance, GIS cannot be analyzed simply as a technological phenomenon, but must also be understood in terms of its social context and the implications of its use (Harris and Weiner 1998; Poore and Chrisman 2006).

Throughout the world, there is a variety of systems that are employed to manage access to natural resources including private property rights, open access rights and community property rights. One of the PGIS mapping of coastal area of Caribbean coast of Central America is given as an example in Fig.1. Much of its coastline of Mosquitia is composed of lagoons, estuaries and mangroves fronted by miles of sparsely settled beach. This mapping was carried out to understand the resource availability, land use the human settlement and the status of forest cover, forest degradation etc., with the involvement of local population. With this PGIS mapping, policy makers could chart out programs for the overall socio economic development of the region and also could come out with measures for people participatory resource conservation.

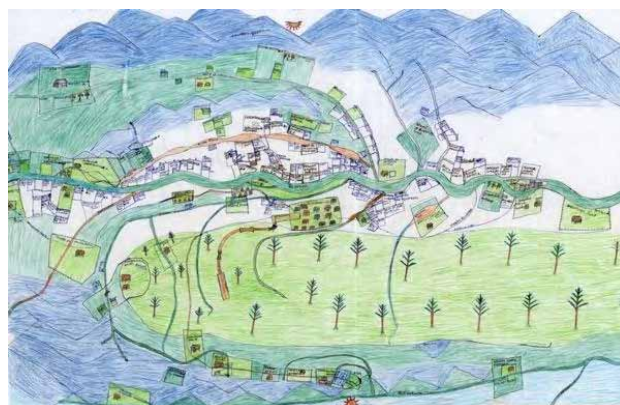


Figure.1. PGIS mapping of Río Patuca, the largest river system in the Honduran Mosquitia of Caribbean coast of Central America.

(Ref: David M. Cochran, Jr. (2009) Placing geographic power in the hands of the people: the potential for participatory GIS in economic development, *Journal of Applied Research in Economic Development* , Volume 6, issue 2, 2009)

For sustainable agriculture in India application of PGIS was proposed as an effective tool creating spatial data base on natural and socio-economic resources with the participation of farmer community. In Indian agriculture sector, there is a coordinated effort being experimented in which farmers are contributing the information regarding physical and chemical properties of the soil, water availability and irrigation facility, crop pattern in their land holding with the geo-location (latitude and longitude) to the policy makers and researchers. This in turn enable the researchers and policy makers to integrate the information to come out with solutions regarding fertilizer requirement, irrigational needs and appropriate crops for the soil and cropping pattern in GIS mapping in wider scale. This coordinated program with geospatial information eventually help in strengthening the database and there by the overall development of the region. More the involvement of the farmers, the better resolution was observed in database which helped in more precise mapping of each component. This participatory effort in GIS platform is leading to tremendous impact in agricultural sector. Similar PGIS activities help the government agencies to understand the needs of the region with minimum expenditure. Offlate the PGIS is used in fisheries in various countries which is generally limited to aquaculture and livelihood related issues in fisheries sector. In India classic example of PGIS in fisheries sector is demonstrated in Chilka lake fisheries (Mishra, 2010).

Agriculture is a land based activity and the resources have specific geo-spatial address. The farmers are more organized sector and the managers and policy makers in agriculture are often have the opportunity to check the validity of the data with onsite inspection. Unlike in agriculture, fishery managers and policy makers in marine fisheries sector have little chance in conducting onsite observation in the fishing grounds where commercial fishing operation is going on. Fish landed at fisheries harbours are not representing the resource status of the fishing ground, since only a portion of the catch which is commercially important is brought to the shore and rest is discarded for which no information is available. Unless the fishermen themselves decide to contribute the information to the government agencies, the government agencies which are involved in the policy making in fisheries sector had to depend on the information available from secondary sources which often lack the sea truth. Many of the prediction models on the fishery potential and determining sustainability issues are based on the data available for the analysis and the accuracy of the predictions and related restrictions on fishery depend on the accuracy of the data available for the analysis. Fishermen are the major stakeholder who is impacted by marine fisheries regulations and also due to lack of it. So it is the responsibility of the fishermen to provide the most accurate sea truth data for the researchers and policy makers to have most appropriate policies which reflect the reality. In present fishing scenario it is absolutely impossible to have an Institutional mechanism to collect spatio-temporal data on the fisheries resources. Due to these intricacies in data collection, practice of participatory GIS program extremely important and effective tool in marine fisheries management. This will enable the fishermen to impart effective influence in decision making in fisheries with their traditional know how and the actual fishing information. In Indian fisheries scenario

where the sea is considered as common property any regulation in marine sector can meet success only with the cooperation of fishing community. For this tools like interactive maps are effective. Geographic information science can provide useful and powerful tools, by which fishermen themselves could decide about future and the projection made out of the GIS information could illustrate the probable fate of the fishery if it is continued in present state. PGIS will act as a “community based natural resource management (CBNRM)” for overcoming present management obstacles and for establishing sustainable resource management policies.

With rapid technological development, marine fisheries production from coastal waters of India reached almost its predicted potential. There is an immediate need for management interventions to make the production sustainable and to conserve the marine living resources. It is a fact that most of the management options evolved during different periods of fisheries development for sustaining marine fisheries did not yield the desirable results because of non-acceptance and non compliance of management regulations by the fishermen. Enforcement of regulations was not successful as the fishermen believed that the policies do not represent ground realities and research findings were not presented in a convincing manner. Trawlers are the major mechanized fishing fleets which contribute to the fisheries production especially along the west coast of India. Analysis of Indian marine fisheries production trend showed that 80% of the marine fisheries catch was from trawlers and during last decade trawlers are further equipped with modern gadgets and more engine capacity to fish more vigorously leading to increased contribution from these fleets. Intensity of trawl fishing has a vicious impact on benthic ecology and biodiversity. Ever since the operation of fishing fleets extended beyond 30m to 50m, spatial characteristics of the fishery remained unknown for the researchers and policy makers and without incorporating the knowledge about the spatial distribution of fishes, no fishery management policies were comprehensive. In this scenario data sharing of spatial component of the fishing ground and fishery by the fishermen has become a crucial component in the formulation of acceptable fishery management policies. Participatory approach in fisheries research can provide most of probable solution in fisheries management by providing illustrative research support in spatio-temporal fishing effort restriction, avoidance of juvenile exploitation, reducing the bycatch and applications of ecological and trophic relations in fisheries management. The analysis of the data also provide information on fish assemblages, biological loss due to bycatch/discarding, spatio-temporal biodiversity changes in fishing grounds. Ignoring the spatial component often ads to inaccurate estimate and often leads to misleading interpretation on the distribution and biology of species like growth, feeding, reproductive pattern etc. GIS is a powerful tool which integrates the spatial component with the present temporal studies. GIS rarely appears within the institutionalized system of science in many countries. Off late fishery scientists are utilizing the possibility of this science and GIS is now being used as a tool for fisheries management and fishery resource conservation measures. Socioeconomic constraints such as levels of education and financial resources with which GIS and allied instruments can be procured and operated, was the major lacuna in incorporating spatial data in fisheries research but the present fishery fleets and fishermen have acquired and got acquainted with GPS, which can give basic input for GIS, which in

turn should work as an encouragement for the scientists to incorporate spatial component of the fishery in fishery resource management.

Present day mechanized fishing fleets are equipped with the GPS and other highly scientific gadgets and the need is creation of awareness with regard to the utility of the participatory program. From the participatory trawling experiments in Gujarat conducted by national fisheries research Institutes such as CMFRI and CIFT with participation of fishermen of Gujarat, it was obvious that fishermen are more concerned about the sustainability of marine fish production and they are ready to cooperate with researchers. Mangalore Research Centre of CMFRI conducted participatory research program with trawl fishermen of Karnataka coast and data collected from the research was illustrated in resource maps and the success of this participatory research program, by sharing the geological information and biological information on the trawl fishery. During the participatory research program at Mangalore, fishers shared the information collected in each cruise with the scientists, who is involved in resource conservation and resource management. Data base in resource distribution in different fishing grounds was illustrated with maps time to time to the fishers to make them aware about the importance of their contribution and also to ensure their involvement in the process. Database thus created could act as a handy tool for the policy makers for participatory management policies. The spatio-temporal data on distribution and abundance based on geographic information will enable in evolving policies for the improvement of the fishery in terms of restriction in fishing period, fishing pressure etc. It will also help the policy makers to implement restrictions regarding fishing ground and fishing season on the basis of similar strong database of juvenile abundance in space and time. "No fishing zones" and "marine sanctuaries" can be marked on the basis of spatio-temporal data of fish distribution.

Case study: Applications of participatory GIS program in fisheries in marine fisheries management and conservation in Indian scenario (based on preliminary studies along Malabar and Konkan coast)

The case study given below showcases the possibilities of participatory GIS in marine fisheries in India. In this program commercial fishermen engaged in trawling who is having GPS in their boats shared their fishing information and fish samples to the Researchers of Central Marine Fisheries Research Institute for a period of five years from 2007-2012. During this period 1035 days of fishing information and fisheries resource details are collected by the two contributors (fishermen and researchers) of the program. The program could come out with very important informations on the fishing area fishing intensity, resource distribution and biodiversity of the fishing grounds with spatial and temporal variations. Some of the major findings from PGIS program in marine fisheries of Malabar and Konkan coast is given below.

Spatio-temporal distribution of fishes

Till early eighties, when the trawling depth was restricted to 30 to 40 m depth, the species distribution of marine fishes was well understood and documented. But when the fishing depth was extended to deeper waters and fishing operations extended from single day to multi-day, the fish landing data could not provide a distribution of marine resources by depth. Even though experimental trawling provided some useful data, these data were not sufficient to conclude about distribution of fishes. Fishery researchers and managers who is

involved in evolving management policies has left with no option other than assuming that the fishes landed were uniformly distributed in the fishing ground. The results from the present study can give the status of distribution and abundance of the resources which can give an additional information for evolving successful management of these resources. Central Marine Fisheries Research Institute, Kochi have a comprehensive time series database on the species caught by trawlers from 1960 onwards, but the spatial distribution of the species in each season was not clearly understood. 246 species of fin fishes/shellfishes were recorded from trawl landing of Mangalore Fisheries Harbour during 2007-2010. The fishing grounds from which the species were caught remained unknown during regular landing based fishery estimations. But the PGIS program provided a definite information on spatio-temporal distribution of many of these fishes. More than 200 species of finfishes/shell fishes and many un-identified fauna like jelly fish, gorgonids, echinoderms, coral fishes, juveniles of shark and ray were recorded from the catch. Spatial distribution of reef related fishes mapped with the information provided by fishermen under PGIS program is given in figure 2 as an example of to show the utility of PGIS tool in resource mapping.

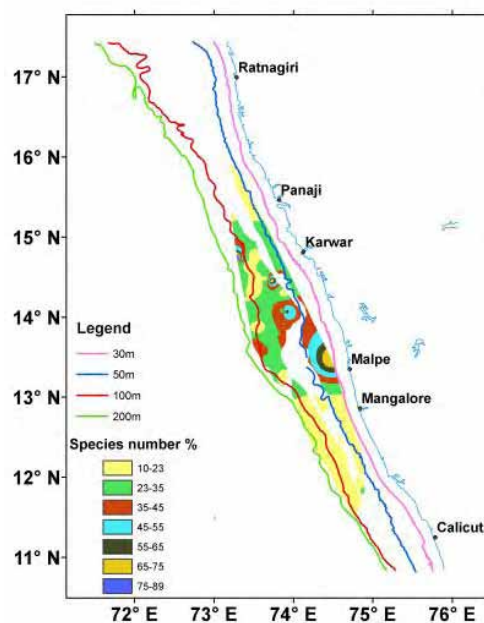


Figure 2. Distribution of reef related species mapped from PGIS program in marine fisheries along west coast of India

Utility in studies of damage assessment in fisheries

These maps when it is drawn by pooling all data points collected irrespective of months/seasons may look less informative, probably giving a picture of overall distribution of species or area of fishing operation. For decision making in fisheries management, monthly or seasonally resource mapping is essential. Based on monthly and annual resource mapping, effort restrictions in particular fishing grounds can be suggested to reduce the resource damage. Intensity of fishing pressure mapped on the basis of the information

provided by fishermen under PGIS program is given in the figure 3. This example emphasizes the role of PGIS decision making in fisheries management.

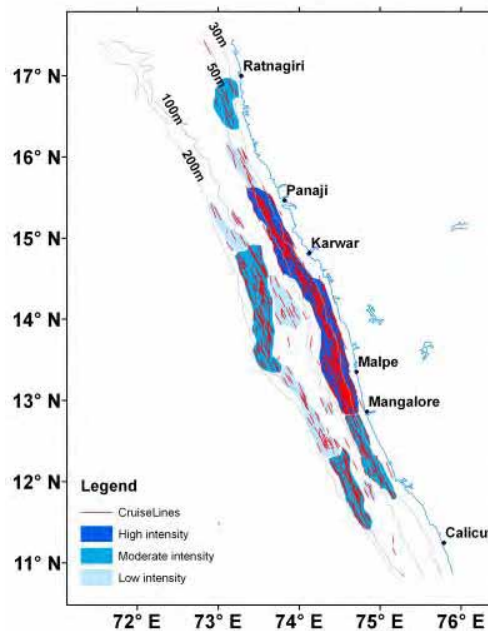


Figure 3. Extend of fishing ground and intensity of fishing at different fishing grounds mapped from the data provided by commercial trawlers operated along west coast of India under PGIS program.

Conclusion and way forward

Spatial and temporal distribution pattern from the catch and discard of commercial trawlers, which use non selective gear (trawls), can give a clear picture of resource distribution in commercial fishing grounds. The data base created in GIS platform with illustrations in the form of maps will work as a tool for the policy makers to find mutually agreeable solution to tackle problems in conserving and managing the fishery with the active participation of fishermen. Today many of the findings by scientific methods could not be presented in a convincing manner to the policymakers and end users, due to incapability of visual projection. GIS can provide visual projection of spatial and temporal distributions and abundance of fish populations and juvenile abundance. The fish populations are controlled by the interactions between organisms and their surrounding environmental characteristics. Hence oceanographic data on temperature, salinity, bathymetry, wind pattern, currents and water mass movement and productivity can be integrated into the routine application of this software. Spatio-temporal distribution of species and its juveniles (species-wise), spatio-temporal resource maps of all species (adults and juveniles) from different fish grounds, fish assemblages with reference to the depth and season, dependencies of different group of fishes, biological loss and biodiversity loss due to fishing can be derived from such studies.

More involvement from fishermen, will fill the lacuna in data faced in the present study, by which multiple spatial data from different fishing grounds for a single day would be possible and the results will be comprehensive. Based on the qualitative and quantitative

availability of all these components of the fishery, each fishing ground can be evaluated seasonally in economic and biodiversity terms. Such overall information on fishing ground and resource mapping will enable the policy makers to demonstrate the impact of fisheries to the fishermen in visual format and make most appropriate policies in restricting particular fishing ground in particular period. This participatory decision making could also create awareness, to avoid capturing juveniles without causing much difference in their income. Spatio-temporal resource mapping for long term basis will also help in conservation of human and fuel resources which is spent in search of fishes.

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Availability and Accessibility of Research outputs of CMFRI through eprints@cmfri: An Open Access Institutional Repository

V. Edwin Joseph

Officer-in-charge

Library and Documentation Centre

CMFRI, Cochin

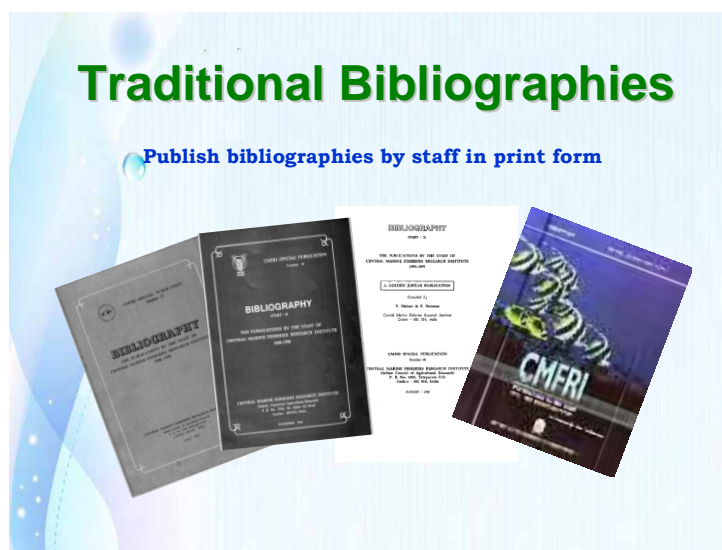
Introduction

CMFRI is the oldest Marine Fisheries Research Institute in India. The main outcome of the publicly funded marine research is to publish scientific papers. One of the mandates of CMFRI is to act as clearing house of research and general information relating to marine fisheries through its publications and other information that it disseminates. These scientific papers published since 1953 are not well documented for wide spread utility of scientific community both inside as well as outside India. The research output must be applied to achieve the broader developmental objectives of the scientific society which may result in public accountability of the research. But the dissemination of research output is a major challenge and until it is known to the world the research has no meaning. The knowledge of this marine research should be made available for the public freely. The recent developments in Information Communication Technologies (ICTs) has brought drastic changes to conventional communication channels of scientific communications, information, sharing and accessing behaviour of the scholarly community. The ICTs have paved the way for the global Open movement among scholarly communities. Open Access to science and scholarship means making scholarly research articles freely available to the public online without any restrictions. Following this, CMFRI has established an Open Access Institutional Repository.

Traditional way of publishing Bibliographies

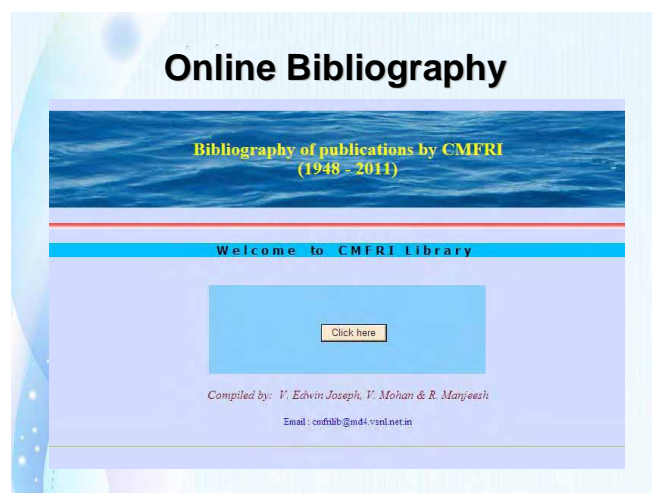
In order to bring the list of research publications in one bunch, the Institute was publishing bibliographies in print form. List of publications by the staff of CMFRI for the period from 1948 to 2006 was published in CMFRI Special Publications Nos. 27, 51, 68 and

96 at various intervals. Though we publish the list of papers in print copies of the bibliographies, the full text of the research papers was not reaching the global audience.



Online Bibliography

Realizing the need of wide spread publicity to the scientific papers world wide and following the recent Information Communication Technologies, CMFRI Library has taken initiation to keep the bibliographical details of the papers published by CMFRI in the INTERNET. The software was developed in MS Access format with keyword search facilities to create a database for CMFRI bibliography. Online Database for CMFRI Bibliography was created for the period from 1948-2008. It was launched during 2008. This is the first online bibliographical database for the scientific papers published by our scientific staff. This may be accessed at: http://www.cmfri.org.in/html/cmfri_intraSPS.html.



Eprints@CMFRI: An Open Access Institutional Repository

The Online bibliography compiled by CMFRI was useful only for knowing the bibliographical details of the papers published by the Institute. Though CMFRI has published more than 10000 scientific papers since 1954, the full text of these articles has not reached the global audience. As a result, citations for these scientific papers are poor. The value of a scientific paper is rated by the citation index. Realising this, CMFRI leadership strongly felt a institutional repository be established to provide open access to the Institute's scientific publications. CMFRI Library took the lead in implementing the IR for Institute's publications. The aim of the IR at CMFRI is to provide an effective means of ensuring the disclosure of and access to the scholarly work research of this Research Institute. As a first phase of IR, full print copies of scientific papers were collected from the scientists published since 1947. Interestingly the authors were reluctant to deposit their scientific papers in the repositories. The reasons could be:

- Uncertainty and fear on copyright issues
- Reservations regarding who and how the material would be used
- Uncertainty about who gets attribution impact and scholarly credit
- Myth of low quality materials in IR

However, these apprehensions were overcome and that finally started the scanning process of the papers since 1947. The digitization work was started during 2009. More than 4 lakh papers have been scanned and these scanned images were converted into PDF and were arranged yearwise.

To enable this repository in the INTERNET, the Open source software developed by the University of Southampton, UK is installed in Library server. The CMFRI IR is given a name *eprints@cmfri*. The scanned 9500 scientific papers centering 5 lakh pages have been uploaded as on August 2013. It may be accessed through website: <http://eprints.cmfri.org.in>

Interested users can freely download and use documents as most of them are directly accessible and full-text downloadable. 'Request copy' forms can be used for documents to which direct full-text download is restricted due to publisher embargo. The following types of publications of CMFRI are uploaded /self archived by CMFRI Scientists who do research on fisheries and related areas.

- Article
- Book
- Book Section
- Conference or Workshop Item
- Dataset (Fisheries Statistics, Census etc)
- Monograph
- Other (Annual Reports, News letters etc)
- Teaching Resource (Training manual, Lecture notes etc.)
- Thesis



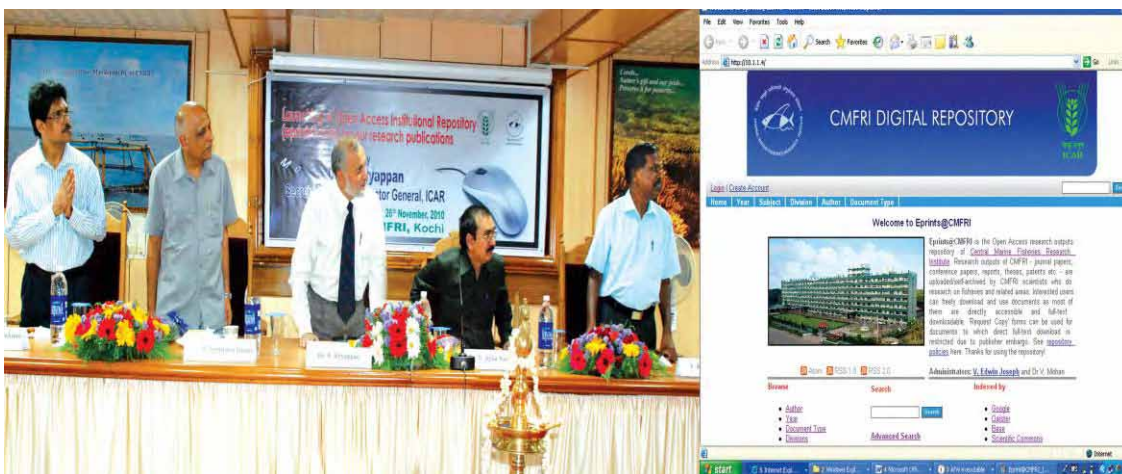
Global Visibility of CMFRI Repository

Realising the importance of the global indexing and search services our eprints only have been registered with the undermentioned international data bases.

- Google
- Google Scholar
- Oaister
- Base
- Scientific Commons and
- Scirus
- AVANO – a Marine and Aquatic Science Open Access Repositories, USA
<http://www.ifremer.fr/avano/>

Inauguration of Eprints@CMFRI

Knowing the importance of this repository, Honorable Dr. S. Ayyappan, Secretary DARE & the Director General, ICAR launched CMFRI Institutional Repository on 26th November 2010 in a function held at CMFRI.



Benefits of CMFRI Open Access Repository

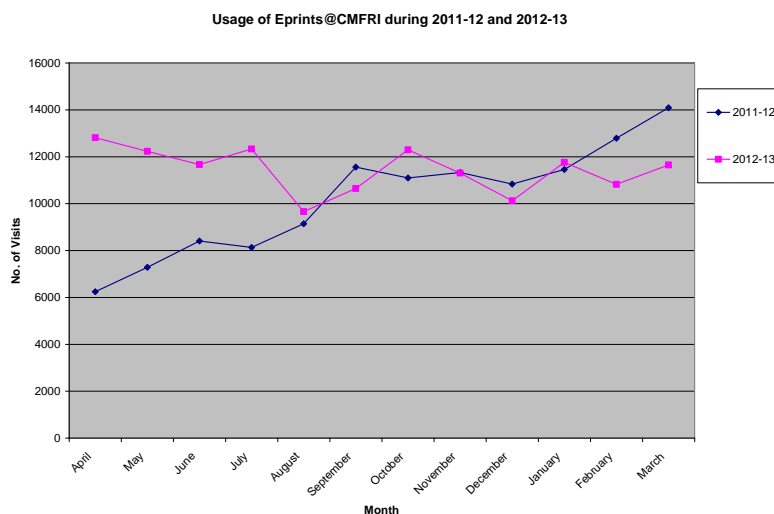
- Prestige of the Institute will be raised when a staff paper is included in Eprints@CMFRI
- Enhances the professional visibility of scientists of the institute
- Serves to demonstrate the breadth and depth of research output of CMFRI
- Open Access Repositories like Eprints@CMFRI offer the widest possible dissemination of scientific findings
- Research has demonstrated that open access online articles have appreciably higher citation rates than traditionally published articles
- Serves to establish priority of ideas and intellectual property, i.e. registering the work with a date stamp and identifier
- The centralized system of documenting the papers manages and presents the research output of the Institute in an organized fashion
- Students/Scientists can easily access faculty papers via Eprints@CMFRI. This provide easier access to the entire publications of CMFRI
- Preserves and provides long-term access to the scholars' research output
- All institutes' papers in one roof will facilitate the policy makers to select the non priority areas in Marine Fisheries
- Scientific output of institute is reaching the global audience immediately

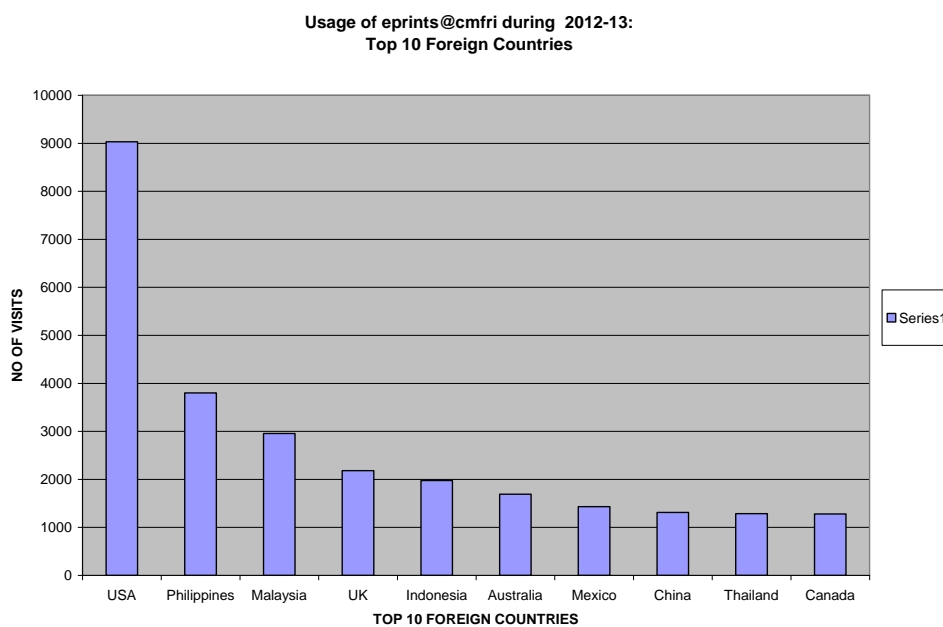
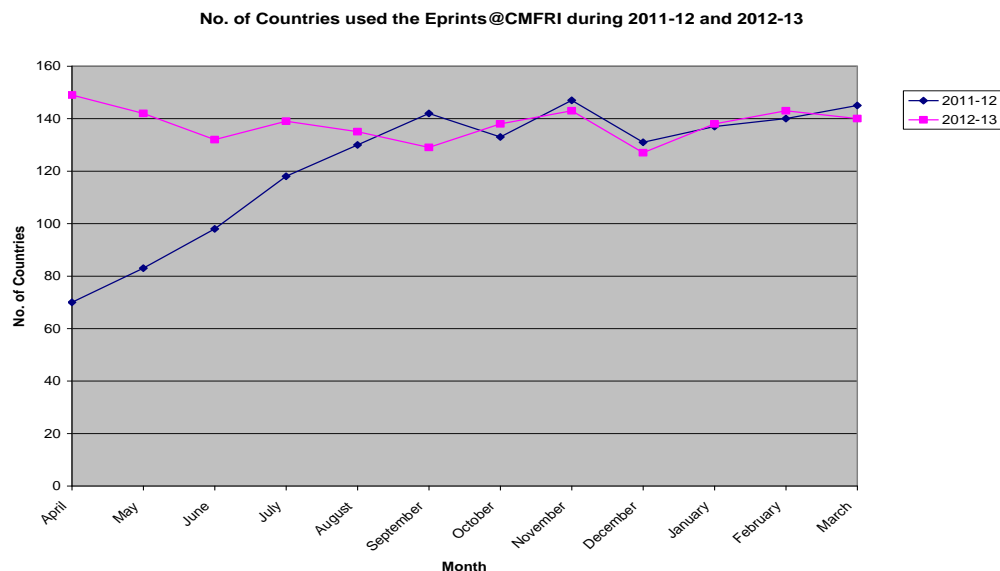
Statistics of the eprints@cmfri

The Library & Documentation Centre has developed its Open Access Institutional Repository viz: eprints@cmfri for Institutional publications, now recognized world wide as a leading research information centre. The Institutional repository facilitates browsing by year of publication, author, department, subject category and document type. Advanced search is possible by author, title, subject and with many options. Our IR has reached 198 countries in the world. More than 350 full text articles contributed by the scientists and staff of CMFRI were uploaded during the period 2012-13, and are available in 'Eprints@CMFRI'. We have uploaded more than 9650 scientific papers.

Monthly statistics of the access of eprints@cmfri
during 2012 to 2013

Month & Year	No. of Visits	No. of Countries
April 2012	12810	149
May-12	12230	142
June-12	11666	132
July-12	12331	139
August-12	9656	135
September-12	10642	129
October-12	12295	138
November-12	11303	143
December-12	10119	127
January-13	11760	138
February-13	10823	143
March-13	11644	140
	137303	1655














The usage of eprints@cmfri for the period April, 2012 to 31st March 2013 has been recorded. More than 198 countries used the repository and 137303 times visited and downloaded full text of scientific papers. Notably, visits from India are highest with 80,563 times followed by USA 9030, Philippines 3801, Malaysia 2953, UK 2181, Indonesia 1975, Australia 1692, Mexico 1431, China 1311, Thailand 1286 times and so on.

India's Best Institutional Repository Award 2012

Registry of Indian Open Access Repositories, a part of Open Access Journals Search Engine (www.oajse.com) had conducted a survey to get Best Institutional Repository in India. After proper verification and evaluation of various parameters, Eprints@CMFRI, the Institutional Repository of Central Marine Fisheries Research Institute (<http://eprints.cmfri.org.in/>) has been selected for the India's Best Institutional Repository Award 2012.

World Rank

Consejo Superior de Investigaciones Científicas (CSIC), the largest public research body in Spain is ranking the World Web IRs, this Institute has released the rank of the world IRs. We are glad to write that our Eprints@CMFRI gets 304th International Rank, 90th rank in Google Scholar and 1st rank among ICAR and 3rd in the Indian IRs.

Ranking Web of World Repositories							
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> home > Top institutional repositories							
Data		Top Institutional Repositories					
About Us		First | Previous | Next | Last | Repositories 301 to 350 of 1154					
About the Ranking		WORLD RANK	REPOSITORY	COUNTRY	SIZE	VISIBILITY	POSITION RICH FILES SCHOLAR
Top Repositories		301	University of Canterbury Research Repository		390	631	137 84
Top USA & Canada		302	King Saud University Repository		469	460	409 156
Top Europe		303	Memorial University Newfoundland Digital Archive		114	255	319 912
Top Institutionals		304	Eprints Central Marine Fisheries Research Institute		295	653	167 90
Top Portals		305	Australian Defence Science and Technology Organization Repository		377	432	371 382
Directory		306	Biblioteca Digital Jurídica do Superior Tribunal de Justicia		261	581	380 99
Methodology		307	ProdINRA Publication de l'INRA		280	496	340 355
Best Practices		308	DIGIBUG Repositorio Institucional Universidad de Granada		279	523	237 397
Information		309	Prince of Songkla University Knowledge Bank		195	349	200 821
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Conclusion

Having a mandate of ICAR for an Open Access which was released on 13th September 2013, the CMFRI could rise up to the expectations with its institutional repository gateway. There was articulated interest among several researchers to publish in open source platforms but researchers remained initially reluctant. With the establishment of

eprints@cmfri, it is possible to provide the researchers with substantial and subject specific information on Open Access and with the institutional repository, CMFRI is able to implement a simple and easy solution for Open Access. Therefore our researchers could project their intellectual products and other research outputs and drawn an attention among their counterparts over the globe. Finally, it can be concluded that greater visibility of our public funded research reaches the global audience through our eprints@cmfri.

ICT -oriented Strategic Extension for Responsible Fisheries Management

5-25 November 2013

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Responsible Fisheries Extension Module consisting of different communication tools developed by SEETT Division.